SOILS REPORT No. 7 1957

REPORT OF

RECONNAISSANCE SOIL SURVEY

OF

CARBERRY MAP SHEET AREA

By

W. A. EHRLICH,

E. A. POYSER AND L. E. PRATT

With a Soil Map covering Townships
8 to 14 Ranges 4 to 18 (inclusive) West
of the Principal Meridian, prepared by
the Manitoba Soil Survey.

MANITOBA SOIL SURVEY

CANADA DEPARTMENT *of* AGRICULTURE,
MANITOBA DEPARTMENT *of* AGRICULTURE AND IMMIGRATION,
AND SOILS DEPARTMENT, THE UNIVERSITY *of* MANITOBA

Report published by the Manitoba Department of Agriculture and Immigration.
Map published by Canada Department of Agriculture.

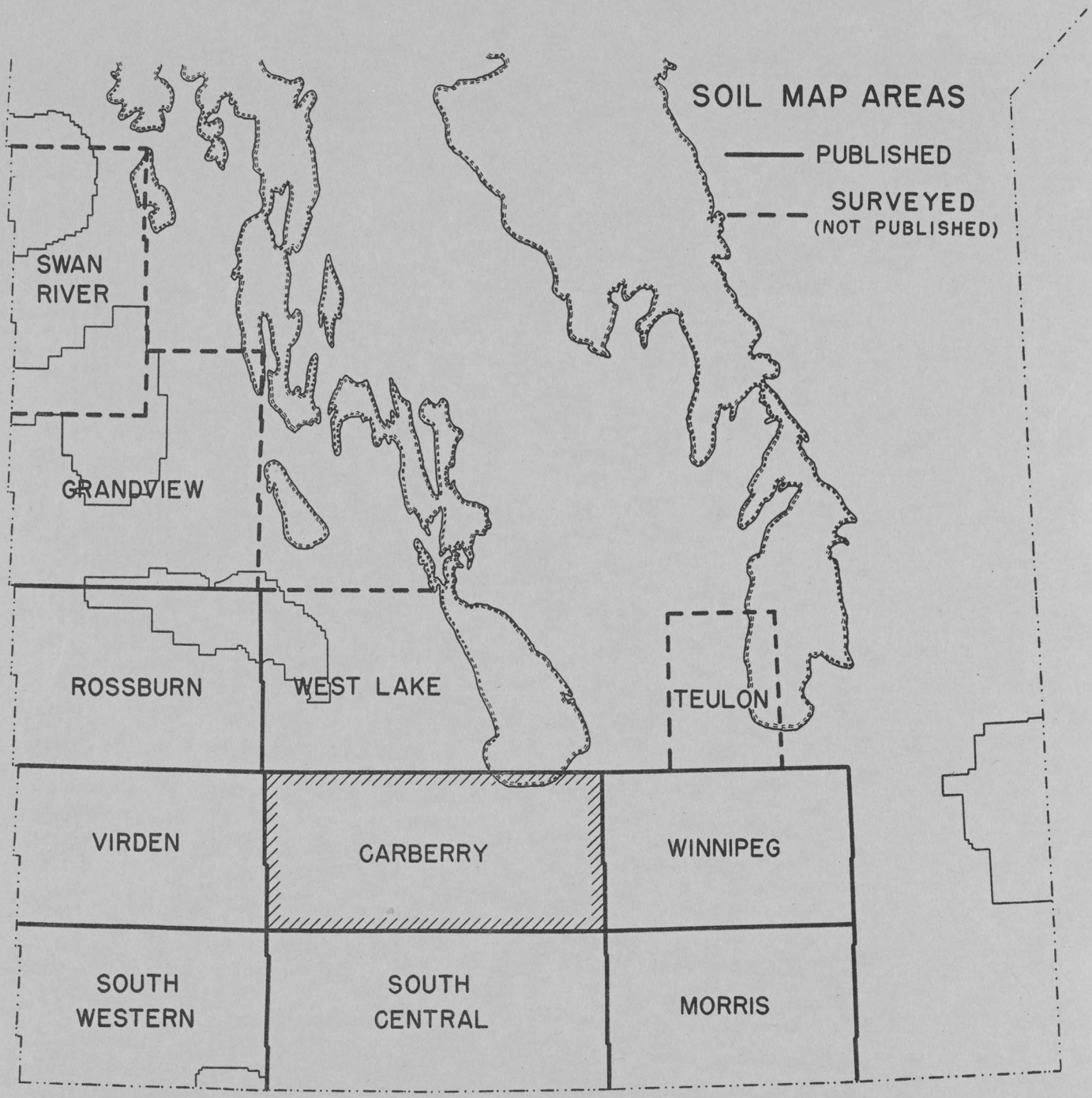
SOIL MAP AREAS
PUBLISHED
SURVEYED
(NOT PUBLISHED)
SWAN
RIVER
GRANDVIEW
ROSSBURN
WEST LAKE
TEULON
VIRDEN
CARBERRY
WINNIPEG
SOUTH
WESTERN
SOUTH
CENTRAL
MORRIS

FIGURE 1

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Acknowledgments

THE SOIL SURVEY of the Carberry Map Sheet Area was conducted as a joint project by the Canada Department of Agriculture, The Manitoba Department of Agriculture, and the Soils Department of the University of Manitoba.

Acknowledgment is made to Dr. A. Leahey, Dr. P. C. Stobbe, Canada Department of Agriculture and Dr. R. A. Hedlin, Department of Soils, University of Manitoba, for their critical review of the report.

The soils were mapped in the field by Wm. H. Shafer, O. G. Caldwell, H. A. Scott, J. M. Parker, R. E. Wicklund, W. A. Ehrlich, and M. Abey under the direction of J. H. Ellis. The writers hereby gratefully acknowledge the services rendered by these men in the field and in the laboratory, and the assistance of Helen E. Gallagher in the preparation of the report. Assistance during correlation work was given at various times by F. P. Leclaire, R. E. Smith and J. A. Robertson.

The colored map which accompanies this report was initially drafted by Wm. H. Shafer. The final drafting and printing of the soil map was undertaken and financed by the Experimental Farms Service, Canada Department of Agriculture, Ottawa, and the printing of the report was undertaken and financed by the Manitoba Department of Agriculture.

Summary

THE RECONNAISSANCE SOIL SURVEY of the Carberry Map Sheet Area covers 3,780 square miles in the central portion of southern Manitoba. The largest part of the area is covered by glacio-deltaic and lacustrine plains, the remainder is covered by boulder till plains and by small areas of recent alluvium. The Carberry map area is divided into two broad physiographic areas by the Manitoba escarpment. Above the escarpment the soils are predominantly well drained, while below the escarpment the topography is flat and the soils are predominantly imperfectly drained. The climate of the area is sub-humid and has a definite summer maximum of precipitation. This climatic condition has resulted in a prairie-aspen grove type of native vegetation over most of the map area. One notable exception is the mixed-woods vegetation on the sand dune area in the central portion of the map sheet.

The soils of the Carberry map area are predominantly Black and Black-Meadow soils. They vary in productivity and adaptability in accordance with their texture, topography and drainage. Grain growing is the principal farm enterprise and over 90 per cent of the cultivated land is utilized for grain and flaxseed production. Generally, wheat is the principal grain crop grown on the medium to fine-textured Black soils, barley is the main crop on similar-textured Black-Meadow soils and oats are the predominant grain crop on the sandy-textured soils. The general cropping practice throughout the area is one year of fallow followed by two years of grain. Livestock are produced in small numbers on most farms in the Carberry area but on some sandy-textured soil areas livestock production is the major farm enterprise.

Introduction

THE RECONNAISSANCE SOIL SURVEY of the Carberry Map Sheet Area is the seventh of a series of reports devoted to the description of the soils of Manitoba as determined through the work of the Manitoba Soil Survey. The object of the survey was to obtain the essential facts about the soils of the area. The publication consists of two parts, a colored soil map and a report.

The Carberry soil map indicates the distribution and area of the soil associations and associates. The soil map was drafted at the scale of one inch equals two miles. Township and Range numbers are shown along the margin of the map. Solid black boundary lines are used to separate associations and phases of associations, and broken black boundary lines are used to separate associates within the associations. Soil associations and phases are identified by color and letter designation. Local soil conditions such as poor drainage, salinity, stoniness and rough topography are indicated by defined symbols A key to the colors, letter designations and symbols appears at the bottom of the map.

The report describes the cultural and physical features of the map area and the formation, character, capabilities and limitations of the soils. The report is divided into four parts. Part I describes the location and extent of the area, the population distribution and the transportation and market facilities. Part II describes the physical features including relief, drainage, geology, climate and vegetation. Part III presents a key to the soils of the area, describes the physical, morphological and agronomic features of each soil association, presents a grouping of the soils into eight land-use classes, and a table indicating the adaptability of each soil to regional crops. Part IV outlines the history of early settlement and describes land-use.

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SOIL ASSOCIATIONS IN WHICH THE DOMINANT SOIL IS A BLACK

SOIL ASSOCIATIONS IN WHICH THE DOMINANT SOIL IS A BLACK-MEADOW OR CALCAREOUS MEADOW

Contents—Concluded

List of Tables

List of Illustrations

List of Illustrations—Continued

REPORT OF THE RECONNAISSANCE SURVEY
of the
SOILS OF THE CARBERRY MAP AREA IN MANITOBA

Part I.

GENERAL DESCRIPTION OF AREA

A. LOCATION AND EXTENT

The Carberry map area lies in the central portion of southern Manitoba. The location of this area with respect to other soil map areas is shown in Figure I. The Carberry map area covers approximately 2,419,200 acres, located in Townships 8 to 14 in Ranges 4 to 18 West of the Principal Meridian. The map area covers the municipalities of Odanah, Langford, Westbourne, North Norfolk, North Cypress and portions of the municipalities of Elton, Cornwallis, Oakland, South Cypress, Victoria, South Norfolk, Grey, Portage la Prairie, Cartier, St. Francois-Xavier, Woodlands and Landsdowne (see Figure 2).

B. POPULATION

According to the 1951 census the total population of the Carberry map area was 40,873. This represents a population density of about 11 people per square mile. Approximately 35 percent (14,274) of these people live in incorporated cities, towns and villages. The population of these urban centers is recorded in Table 1.

MUNICIPALITIES OF THE CARBERRY MAP AREA

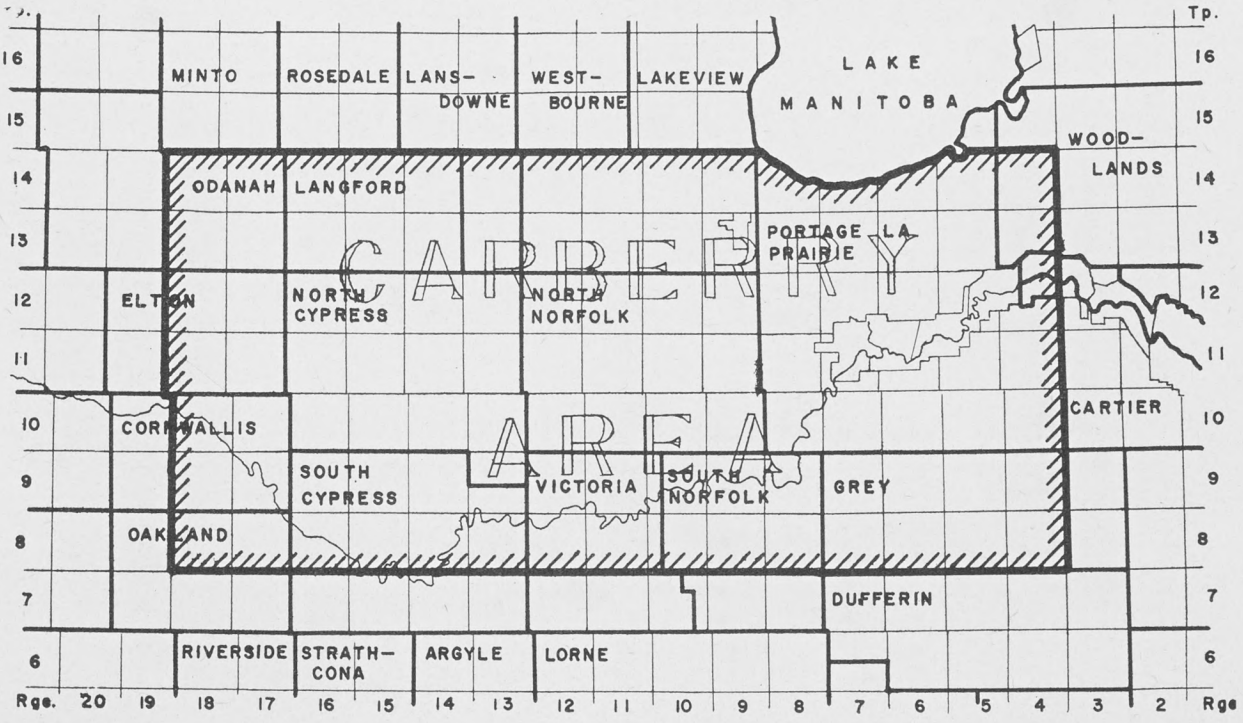


FIGURE 2

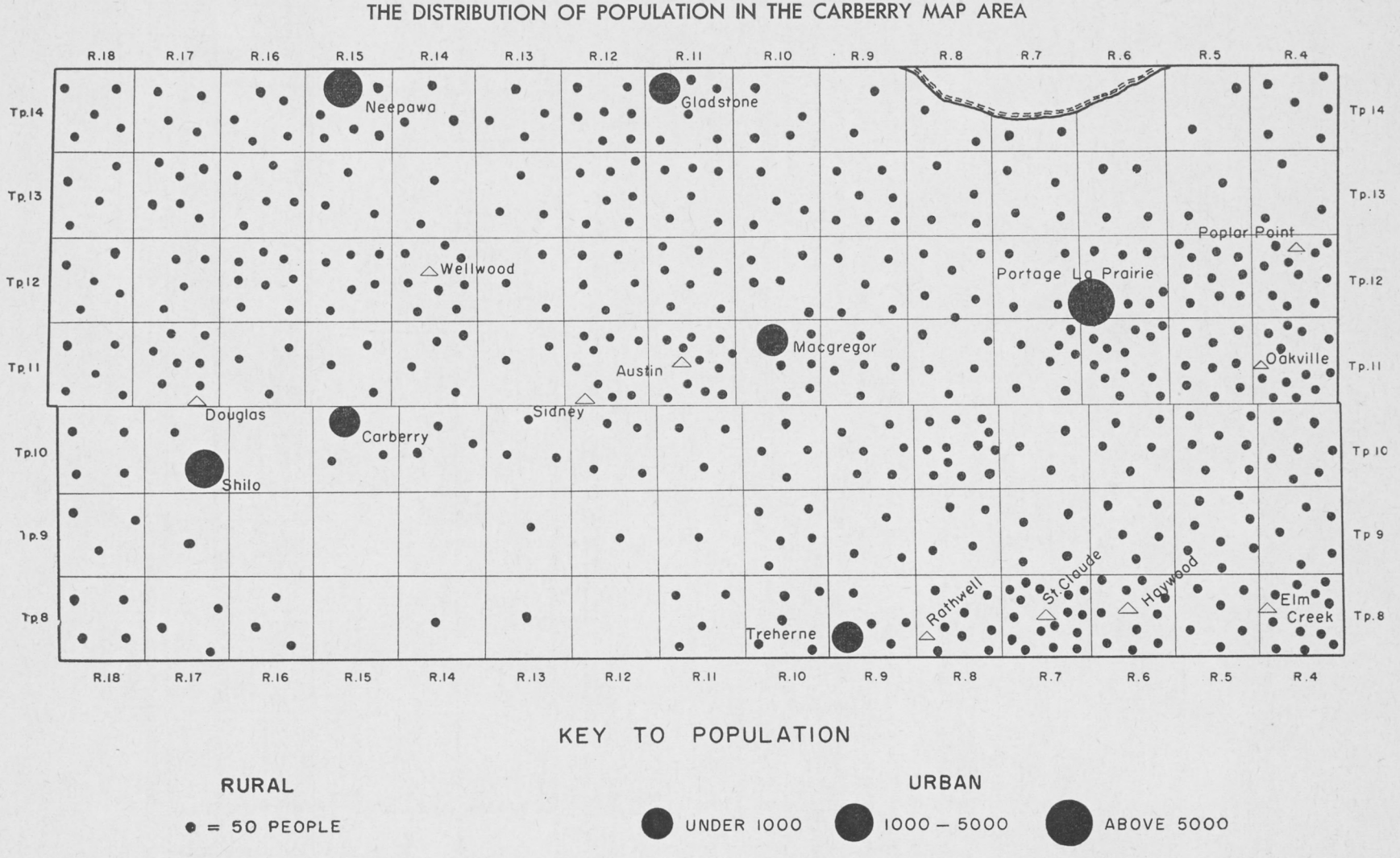

THE DISTRIBUTION OF POPULATION IN THE CARBERRY MAP AREA
R.18
R.17
R.16
R.15
R.14
R.13
R.12
R.11
R.10
R.9
R.8
R.7
R.6
R.5
R.4
Tp.14
Tp.13
Tp.12
Tp.11
Tp.10
Tp.9
Tp.8
Neepawa
Gladstone
Wellwood
Portage La Prairie
Poplar Point
Macgregor
Austin
Oakville
Douglas
Sidney
Carberry
Shilo
Treherne
Rathwell
St.Claude
Haywood
Elm Creek
KEY TO POPULATION
RURAL
● = 50 PEOPLE
URBAN
UNDER 1000
1000 – 5000
ABOVE 5000

FIGURE 3

TABLE 1
Population of Incorporated Cities, Towns and Villages of the Carberry Map Area
(1951 census)

City, Town or Village	Population
Portage la Prairie	8,511
Neepawa	2,895
Carberry	912
Gladstone	828
Treherne	589
MacGregor	539

Approximately 65 percent (26,599) of the people live on farms and in unincorporated towns and villages. The distribution of this rural population is shown in Figure 3. The average density of rural population is approximately seven people per square mile. The density varies over the map area from about 13 people per square mile in the district east of Portage la Prairie to about one person per square mile in the sand dune area south of Carberry.

C. TRANSPORTATION AND MARKETS

The railroads and highways that traverse the Carberry map area provide adequate communication and transportation to the principal market centres. (See Figure 4.)

A network of market roads serve the local farm communities. Most of these roads have been constructed along the road allowances bordering each section of land as provided by the quadrilateral system of survey. Some of these roads are gravelled but more often they are graded earthen roads. Roads are numerous in highly productive farm areas whereas few roads have been constructed in areas with a large percentage of nonarable land. Most of the agricultural produce is transported to markets outside of the map area. The cities, towns and villages in and near the map area provide a limited market for dairy and market garden products. The principal centres which provide processing facilities and markets for the produce of the area are the metropolitan area of Winnipeg, lying approximately 40 miles east of the map area, and Brandon at its western edge.

RAILROADS AND HIGHWAYS OF THE CARBERRY MAP AREA

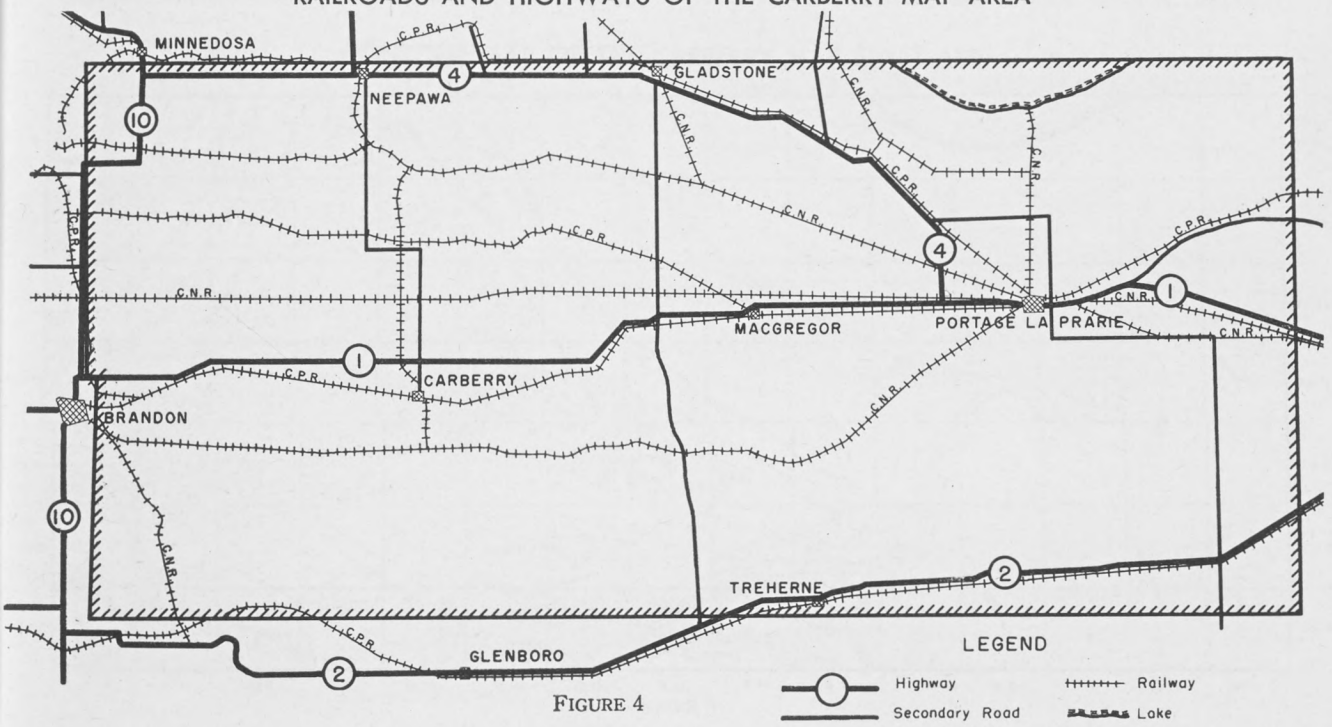


FIGURE 4

Part II.

PHYSIOGRAPHIC FACTORS AFFECTING SOIL FORMATION

The physiographic factors affecting soil formation are climate, vegetation, parent material, relief and drainage. The type of soil formed at any one place is dependent upon the interaction of these factors, the length of time they have been operating and the modifications resulting from the work of man.

A. RELIEF AND DRAINAGE

The principal relief and drainage features of the Carberry map area are shown in Figures 5 and 6.

The elevation of the Carberry map area ranges from 1,800 feet a.s.l. in the northwest corner to 800 feet a.s.l. along the eastern margin. Most of the area is occupied by lacustrine plains with smooth to gently sloping topography. Sharper relief is restricted to the bordering till moraines, the Manitoba Escarpment and the deeply incised channel of the Assiniboine River. The till moraines occupy the area above the 1,300 foot contour in the north-western and south-western corners of the map sheet and have undulating to steeply sloping topography. The Manitoba Escarpment occurs at approximately 1,100 feet a.s.l. and varies in form from a sharp bank deeply incised by ravines to a gently sloping terrace. Above the escarpment, the Assiniboine River occupies a broad U-shaped valley of as much as 200 feet in depth. Below the escarpment the valley gradually diminishes in size to become a shallow channel through the lacustrine plain in the eastern portion of the map area.

The Assiniboine and Whitemud Rivers and their tributary channels drain most of the Carberry map area. The Assiniboine River carries the run-off waters from its large drainage basin in south-eastern Saskatchewan and south-western Manitoba through the map area to the Red River which it joins at the City of Winnipeg.

CONTOUR MAP OF THE CARBERRY MAP SHEET AREA

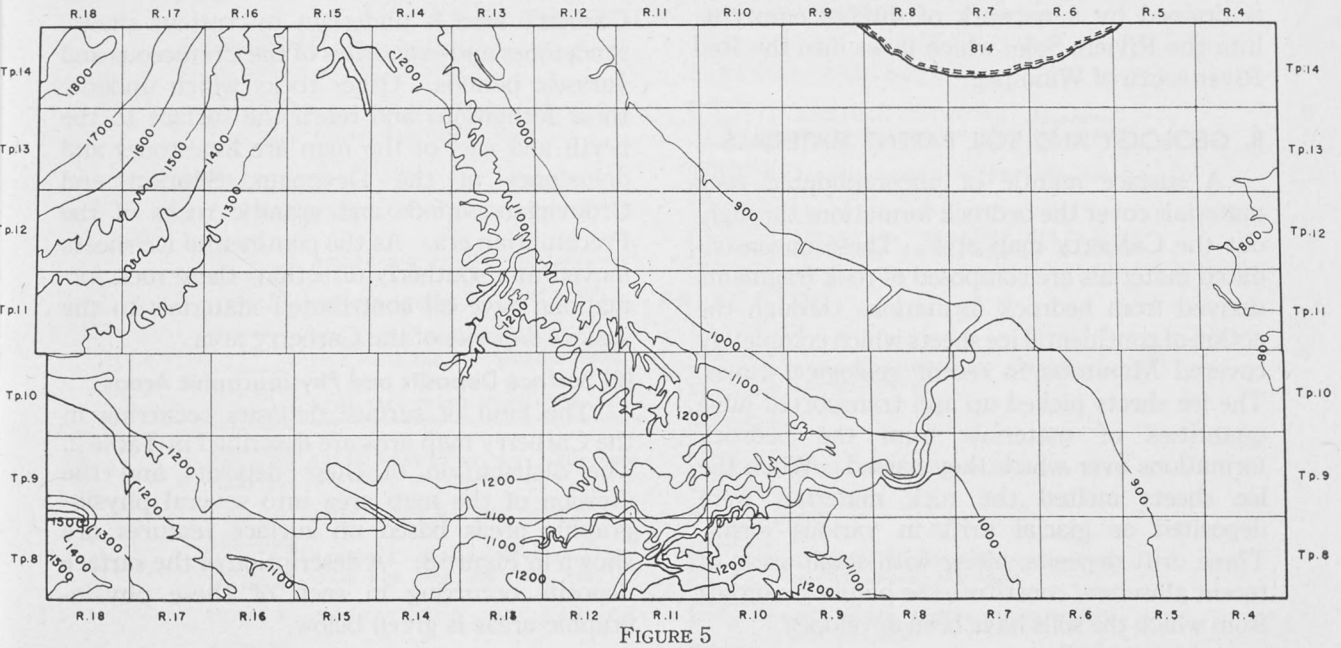


FIGURE 5

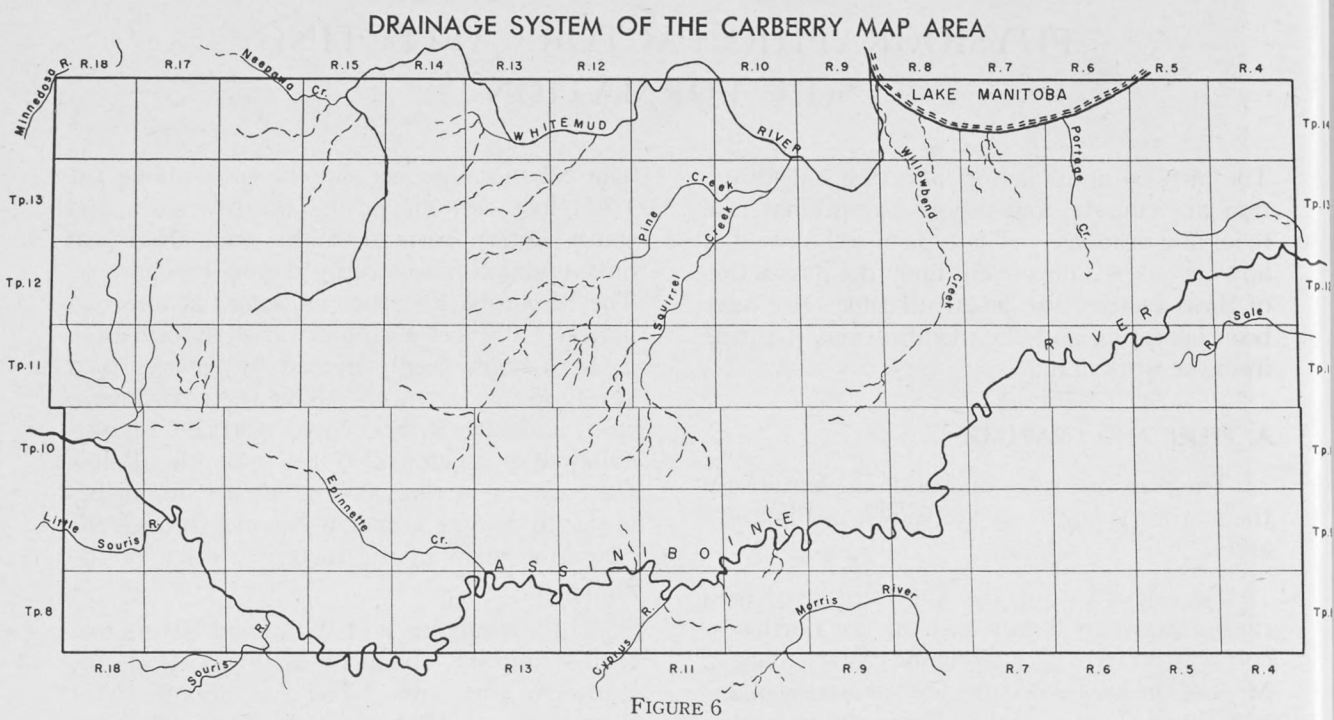


FIGURE 6

Tributary streams of the Assiniboine River drain the southern and western portions of the area. The north-central portion is drained into Lake Manitoba by the Whitemud River system. The flat land in the southeast corner of the area is drained by a network of ditches emptying into the Riviere Sale, which flows into the Red River south of Winnipeg.

B. GEOLOGY AND SOIL PARENT MATERIALS

A surface mantle of unconsolidated rock materials cover the bedrock formations throughout the Carberry map area. These unconsolidated materials are composed of rock fragments derived from bedrock formations through the action of continental ice sheets which completely covered Manitoba in recent geological times. The ice sheets picked up and transported huge quantities of materials from the bedrock formations over which they passed. When the ice sheets melted the rock materials were deposited as glacial drift in various forms. These drift deposits, along with small areas of recent alluvium, constitute the parent materials from which the soils have been developed.

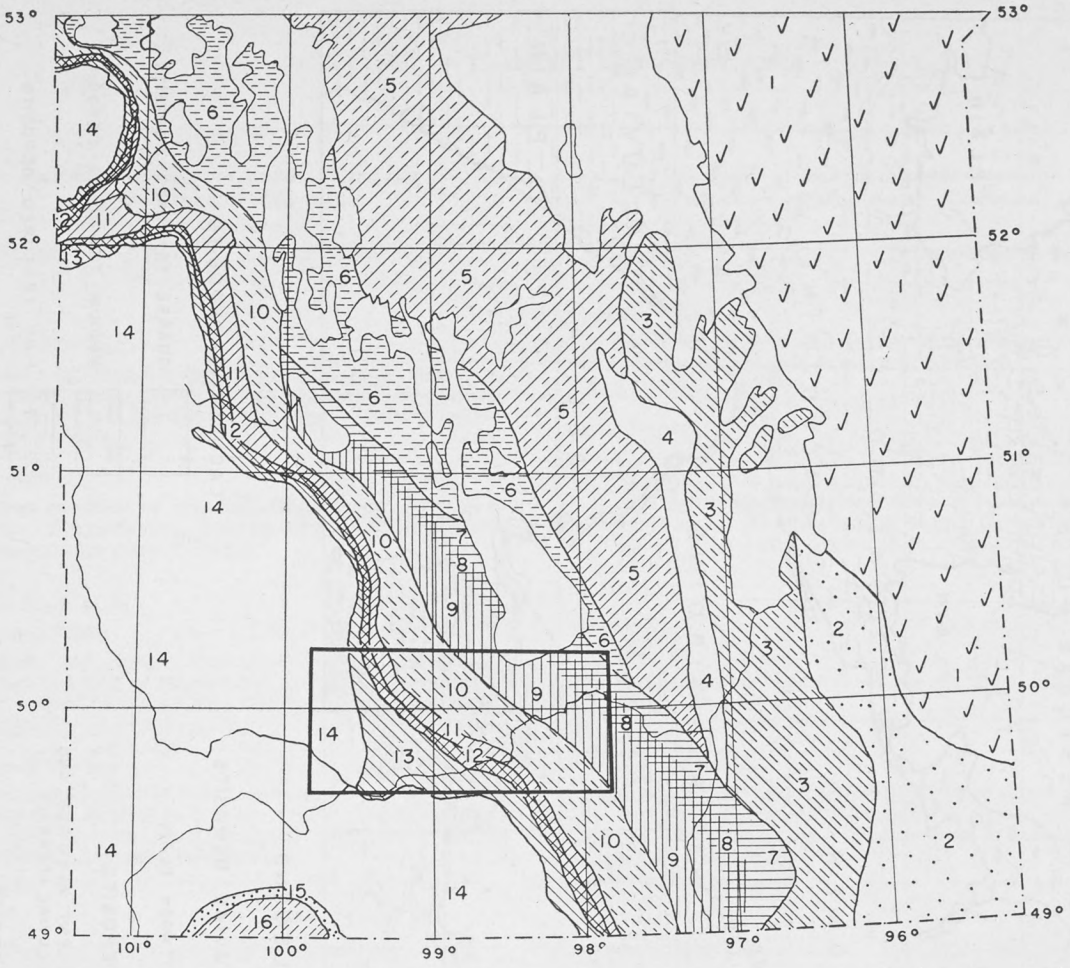
(i) Geology of Underlying Rocks

The bedrock formations of southern Manitoba and the location of the Carberry map area with respect to the surface contacts of these formations are illustrated in Figure 7. The Carberry area is underlain by various shales, sandstones and evaporites of the Cretaceous and Jurassic periods. Other rocks which underlie these formations and reach the surface to the north and east of the map are limestones and dolostones of the Devonian, Silurian and Ordovician periods and granitic rocks of the Precambrian era. As the continental ice sheets moved in a southerly direction, these rock formations have all contributed materials to the surface deposits of the Carberry area.

(ii) Surface Deposits and Physiographic Areas

The kind of surface deposits occurring in the Carberry map area are described in Table 2. The distribution of these deposits and the division of the map area into several physiographic areas based on surface features are shown in Figure 8. A description of the surface deposits occurring in each of these physiographic areas is given below.

LOCATION OF CARBERRY MAP AREA WITH RESPECT TO THE SURFACE CONTACTS OF THE ROCK FORMATIONS OF SOUTHERN MANITOBA



KEY TO ROCK FORMATIONS

CENOZOIC

TERTIARY

16 — TURTLE MTN. FORMATION: Mottled shales and lignite beds

MESOZOIC

CRETACEOUS OR TERTIARY

15 — BOISSEVAIN FORMATION: Sandstone

UPPER CRETACEOUS

14 — RIDING MTN. FORMATION: Light grey hard shale and soft greenish shale

13 — VERMILION RIVER FORMATION: Acid and calcareous shales, some bentonite

12 — FAVEL FORMATION: Grey shale, some limestone and bentonite

LOWER AND UPPER CRETACEOUS

11 — ASHVILLE FORMATION: Dark grey shale with lime and sandy beds

LOWER CRETACEOUS AND EARLIER

10 — SWAN RIVER GROUP: Sandstone, shale and low grade coal

JURASSIC AND EARLIER

9 — SUNDANCE FORMATION: Glauconitic sandstone, shale, limestone and gypsum

8 — GYPSUM SPRINGS FORMATION: Red shale and gypsum

7 — SPEARFISH FORMATION: Red to brown shales and red argillaceous sandstone

PALAEOZOIC

DEVONIAN

6 — UNNAMED DEVONIAN: Limestone and dolostone

SILURIAN

5 — INTERLAKE GROUP: Dolostone

ORDOVICIAN

4 — STONY MTN. FORMATION: Limestone and dolostone, red shale

3 — RED RIVER FORMATION: Limestone and dolostone

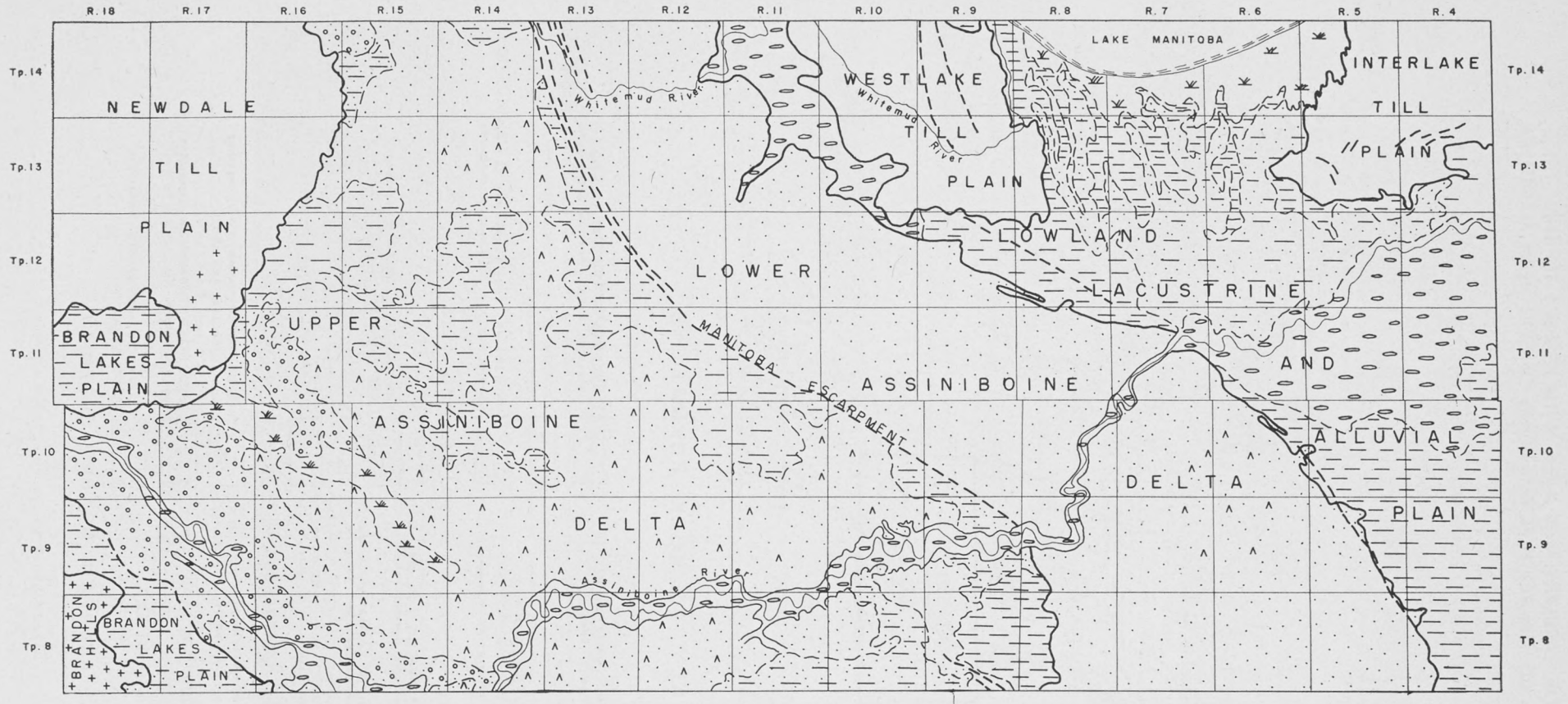
2 — WINNIPEG FORMATION: Sandstone, minor shale

ARCHEAN OR PROTEROZOIC

Chiefly acidic intrusive rocks

FIGURE 7

SURFACE DEPOSITS AND PHYSIOGRAPHIC AREAS OF THE CARBERRY MAP AREA



LEGEND

GLACIAL TILL DEPOSITS

- GROUND MORAINE
- END MORAINE

AEOLIAN DEPOSITS

- SAND DUNES

GLACIO–FLUVIAL DEPOSITS

- OUTWASH PLAIN

ALLUVIAL DEPOSITS

- RECENT ALLUVIUM AND ALLUVIAL TERRACE

ORGANIC DEPOSITS

- MARSH

LACUSTRINE DEPOSITS

- COARSE TEXTURED DEPOSITS
- MEDIUM TEXTURED DEPOSITS
- FINE TEXTURED DEPOSITS
- ESCARPMENTS AND BEACH BARS

FIGURE 8

TABLE 2

Description of Surface Deposits Occurring in the Carberry Map Area

Deposit	Description
GLACIAL TILL	
Ground Moraine	Generally unsorted material. Topography is characterized by a succession of low knolls and depressions Textures are loam to clay loam—contains stones and boulders.
End Moraine	Often modified or resorted. Topography is rough to hilly. Textures range from sandy loam to clay loam—stonier than ground moraine.
GLACIO-FLUVIAL	
Outwash Plain	Sandy and gravelly area occurring in a nearly level plain but may be marked by enclosed depressions and by incised ravines. Often cobbly but usually boulder-free.
Alluvial Terrace	Sandy and gravelly bench along a valley. Topography is gently sloping to the main valley. May contain incised runways and enclosed depressions — often cobbly but usually boulder-free.

TABLE 2

Description of Surface Deposits Occuring in the Carberry Map Area—(Continued)

Deposit	Description
Kame	Short hill of sand and gravel—may contain resorted till. Contains some stones and boulders.
LACUSTRINE	Clays, silts and sands laid down in glacial lakes. Topography is usually level to very gently sloping, although moderately steep slopes are encountered in some areas. Usually free of stones but some stones occur where thin lacustral deposits are underlain with till.
AEOLIAN	
Dune	Sand-textured material blown up into hillocks or dunes. Free of stone.
RECENT ALLUVIAL	Post-glacial deposits of sands, silts and clays. Usually found along streams. Also includes mucks and peats. Soils are immature. Topography is nearly level. Usually free of stones.

FIGURE 9

The Brandon Lakes Plain in the foreground is composed of lacustrine deposits with smooth topography. The Brandon Hills in the background are composed of hilly morainic deposits.

NEWDALE TILL PLAIN—An extensive area of ground moraine with smooth to undulating topography. Some end moraine deposits with slightly rougher topography and containing coarser-textured materials occur in the southeastern portion The periphery of the till plain is incised by numerous prominent ravines containing some outwash deposits.

BRANDON HILLS—A hilly area of end moraine containing some kame-like deposits. Many of the depressions contain lacustrine and alluvial materials.

BRANDON LAKES PLAIN—A smooth lacustrine plain bissected by outwash deposits bordering the Assiniboine River. The materials in the southern portion of the plain are silty in texture whereas the materials in the northern portion are predominately clay.

UPPER ASSINIBOINE DELTA—An area of outwash and lacustrine plains above the Manitoba Escarpment. The outwash plain bordering the Assiniboine valley has gently sloping topography and is dissected by several glacial spillways. The lacustrine plain is composed of coarse, medium and fine-textured deposits. The coarse-textured deposits have been modified by wind and sand dunes occupy most of this area. The medium-textured deposits in the central and southern portion of the delta have smooth level topography and are underlain at shallow depths by thick beds of stratified sands. The medium-textured deposits bordering the Manitoba Escarpment to the north of the Assiniboine River are deeply incised by numerous ravines, whereas the fine-textured deposits south of the Assiniboine River have smooth level topography.

LOWER ASSINIBOINE DELTA—A smooth sandy lacustrine plain below the Manitoba Escarpment. The sandy deposits vary from three to fifteen feet in thickness and are underlain by lacustrine clays and boulder till. An area of sand dunes occurs south of the Assiniboine River.

LOWLAND LACUSTRINE AND ALLUVIAL PLAIN —A smooth plain consisting of medium to fine-textured deposits. These deposits constitute

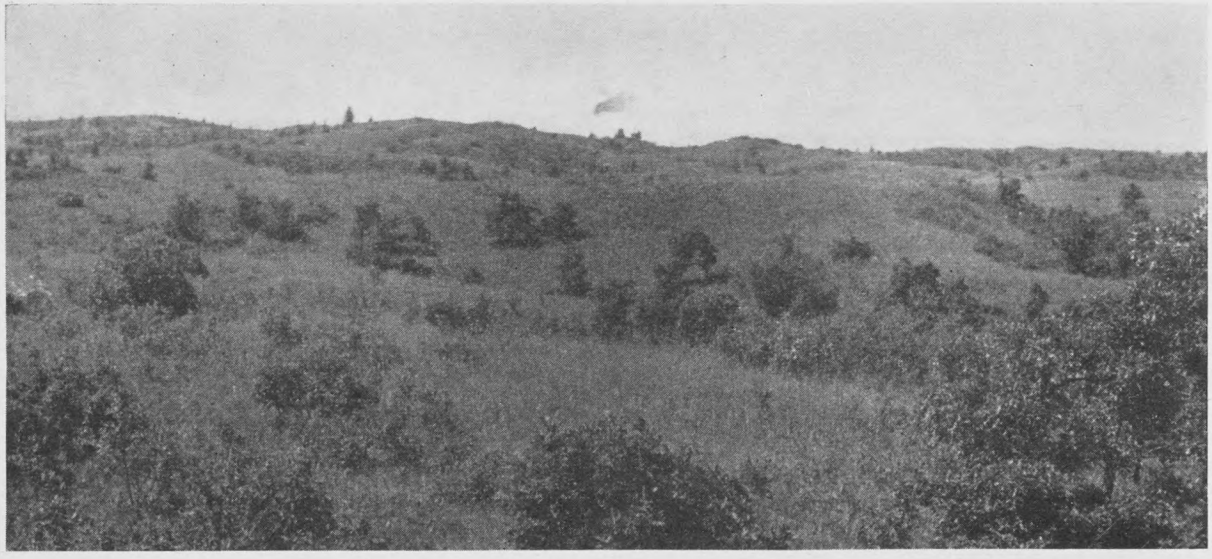


FIGURE 10

The sand dunes in the Upper Assiniboine Delta have been tied down by grassland and woodland vegetation (Note spruce in the background).

the north-western portion of an extensive area sometimes referred to as the Red River Plain. The alluvial deposits bordering the Assiniboine and Whitemud rivers are mostly underlain by lacustrine clays.

INTERLAKE AND WEST LAKE TILL PLAINS—Areas of ground moraine somewhat reworked by shallow waters of glacial lakes. A distinctive ridge and swale pattern was developed in some areas. Thin lacustrine deposits occupy many depressions and the ridges are usually very stony. A few gravel and sand beaches occur across the direction of land fall.

ASSINIBOINE RIVER VALLEY—The Assiniboine River flows in a broad U-shaped valley through the Upper Delta; a shallower, sharp banked, flat bottomed valley through the Lower Delta; and in a shallow channel through the Lowland Alluvial and Lacustrine Plain. Alluvial terraces and recent alluvium constitute the surface deposits in the Assiniboine River Valley.

C. CLIMATE

In relation to world-wide climatic conditions, the Carberry map area of Manitoba is within the region designated by Köppen as Dfb.* This is an area which lies in the centre of the continent, a great distance from the oceans and their moderating effect on temperatures. Summer temperatures are higher, winter temperatures lower, and the annual range much greater than the world average for the latitude. The area is sub-humid and has a definite summer maximum of precipitation. Approximately 80 percent of the precipitation falls as rain during the period of April to October and 20 percent as snow during the five winter months of November to March. These climatic conditions have resulted in a prairie-aspen grove type of native vegetation over most of the map sheet area.

(i) Temperature

The mean monthly temperatures and the highest and lowest monthly means as recorded at Portage la Prairie are given in Table 3. This meteorological station is located in the east-central portion of the map area and in a general way the data are representative of the area as a whole. July is the warmest month with an average temperature of 67.4°F. However, July mean temperatures have ranged from a high of 74.6°F, recorded in 1936, to a low of 61.5°F, recorded in 1891 and 1915. January is the coldest month with an average temperature of −1.0°F. The highest January mean temperature on record is 16.0°F, recorded in 1944, and the lowest is −15.9°F, recorded in 1950.

There is no single, standard method of reporting the length of the growing season, because it varies with different crops and with the same crop under different conditions. However, two commonly recognized values which indicate the length of this period are the frost-free period and the vegetative season.* In the Carberry map area the frost-free period is approximately 100 days and the vegetative season is within the range of 170-180 days.**

(ii) Precipitation

The mean monthly precipitation and the highest and lowest monthly totals as recorded at Portage la Prairie are given in Table 4. June is the wettest month with an average precipitation of 3.21 inches. However, rainfall during June has ranged from a high of 9.10 inches, recorded in 1944, to a low of 0.42 inches, recorded in 1900. February is the driest month with an average precipitation of 0.61 inches. The highest February precipitation on record is 1.58 inches, recorded in 1908, while no precipitation was recorded during February of 1911. The yearly mean precipitation at Portage la Prairie is 18.46 inches. During the 43 years in which complete records have been kept there has been 8 years in which the precipitation was between 12 and 15 inches, 21 years in

*W. Köppen and Geiger. "Handbuch der Klimatologie", Bond I Teil C, Gebuder Borntraeger, Berlin, 1936.

*Frost-free period is the length of time between average dates of the last frost in spring and the first frost in autumn. Vegetative season is the average length of time during the summer months when the mean daily temperature is above 42°F.

**B. W. Currie. "Vegetative and Frost-free Seasons, Prairie Provinces and Northwest Territories" Physics Department, University of Saskatchewan, 1954.

TABLE 3

The Mean Monthly Temperatures and the Highest and Lowest Monthly Means on Record for Portage la Prairie in the Carberry Map Area of Manitoba

Month	Number of Years Recording	Mean Monthly Temperatures in Degrees Fahrenheit	Range of Mean Temperatures	
			Highest Monthly Mean on Record	Lowest Monthly Mean on Record
January	40	−1.0	16.0 (1944)	−15.9 (1950)
February	39	2.3	13.0 (1952)	− 9.8 (1914)
March	38	17.9	35.2 (1910)	1.6 (1899)
April	58	38.1	47.5 (1900)	26.1 (1907)
May	64	51.8	59.0 (1922)	38.7 (1907)
June	64	61.8	70.0 (1933)	54.0 (1926)
July	63	67.4	74.6 (1936)	61.5 (1891 and 1915)
August	61	64.6	71.1 (1949)	59.7 (1904)
September	59	54.5	62.2 (1948)	48.3 (1903)
October	62	42.3	50.0 (1947)	30.0 (1925)
November	39	23.9	38.5 (1890)	13.9 (1895)
December	37	7.8	19.9 (1913)	− 6.0 (1917)

which the precipitation was between 15 and 20 inches, and 14 years in which the precipitation was between 20 and 28 inches.

On the average, 14.5 inches of precipitation falls as rain during the summer months of April to October, and 4 inches of precipitation is received during the winter months of November to March, mainly in the form of snow.

(iii) Local Variation in Climate

The mean monthly temperature and precipitation at each meteorological station in the Carberry map area is presented in graphic form in Figure 11. Winnipeg also is represented for comparative purposes. A study of these graphs indicates that although the general pattern of temperature and precipitation distribution is similar throughout the map area, some minor variations exist. The north-western portion of the map area, represented by Minnedosa, has a slightly cooler summer than prevails over the rest of the area. Winter temperatures show little variation. Total annual precipitation is slightly lower in the western portion of the map sheet and this appears to be due to less rainfall in the spring and autumn seasons. All stations in the Carberry map area receive less precipitation than Winnipeg, located 35 miles to the east.

Other local variations in climate not indicated by these meteorological data exist due to abrupt changes in elevation. These occur in the Brandon Hills and along the Manitoba Escarpment. Air temperatures are slightly cooler over the higher land and precipitation tends to be greater due to forced air lift. An increased moisture efficiency in these areas is indicated by a greater prominence of forest vegetation. Variations in micro-climate also exist due to differences in exposure, which cause variation in the amount of insulation received by the land surfaces. The cooler, and therefore more humid, micro-climate of the north and east-facing slopes is reflected by their forest vegetation. This effect is prominently displayed in the Brandon Hills and in the valley of the Assiniboine River.

D. VEGETATION

The Carberry area lies at the southern edge of the Boreal Forest Region as delineated by

Halliday.* Most of the area is within the aspen-oak section of this region. However an isolated area designated as mixed-woods section occurs in the Upper Assiniboine Delta, and that portion of the Lowland Plain south of the Assiniboine River lies in the Grassland Formation. Halliday describes the aspen-oak section of the Boreal Forest as a transition zone between the Boreal Forest and the Grassland Formation. Aspen is the most prevalent species, ranging from small groves invading the grassland through larger and irregular clumps to closed woodland stands. A general distribution of bur oak is characteristic of this section. The mixed-wood section is distinguished on the presence of white spruce and tamarack.

Since settlement the native vegetation has been modified by the land-use practices introduced by man. Large areas have been cleared for the production of agricultural crops.

*Halliday, W. E. D. "A Forest Classification for Canada". Forest Service Bulletin, N.89. Canada Department of Mines and Resources.

In other areas the vegetation has been altered by forestry operations, the grazing of domestic animals, and the introduction of new plant species. However remnants of the native vegetation still exist in some uncultivated areas. A description of vegetation as observed on these virgin sites is presented by physiographic areas.

NEWDALE TILL PLAIN—An area in which tall prairie grasses are interspersed by aspen-oak groves. The combination of open grassland and local woodland on the rolling Newdale till plain form a park-like landscape. The grasses, which are predominantly spear grass, blue stem, wild rye and wheat grass species, occur on knolls and on south and west slopes. The aspen-oak groves occur on north and east slopes and bands of aspen, balsam poplar and willow surround wet depressions.

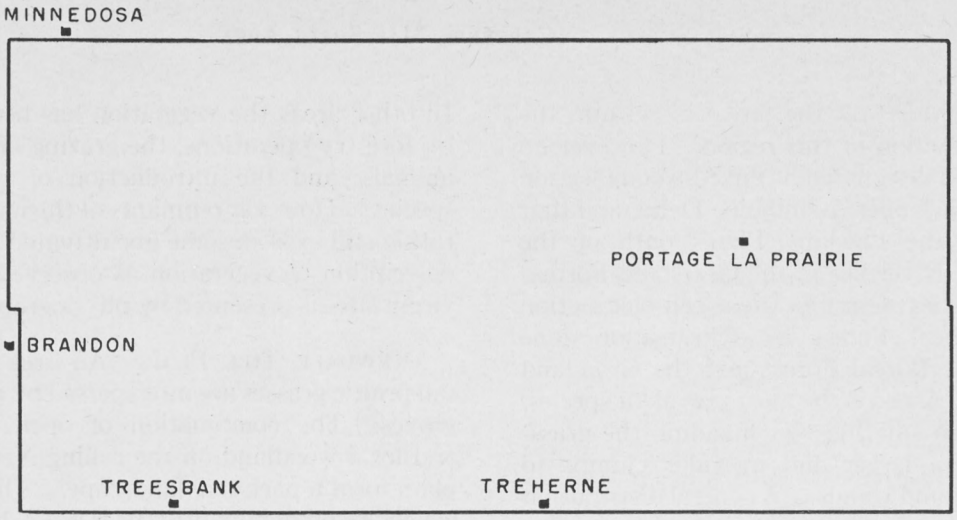
BRANDON HILLS—Dominantly an area of aspen-oak woods but with mixed prairie grasses on smooth south slopes. Viewed from the north

TABLE 4

The Mean Monthly Precipitation and the Highest and Lowest Monthly Totals on Record for Portage la Prairie in the Carberry Map Area of Manitoba

Month	Number of Years Recording	Mean Monthly Precipitation in Inches	Monthly Precipitation Range in Different Years	
			Highest Monthly Precipitation	Lowest Monthly Precipitation
January	46	.77	3.05 (1913)	.00 (1909 and 10)
February	46	.61	1.58 (1908)	.00 (1911)
March	47	.87	2.92 (1942)	.03 (1889 and 1911)
April	66	1.21	4.66 (1896)	.00 (1903)
May	68	1.95	5.14 (1950)	.04 (1900)
June	69	3.21	9.10 (1944)	.42 (1900)
July	70	2.67	7.17 (1924)	.15 (1902)
August	69	2.23	9.31 (1933)	.21 (1930)
September	70	1.97	6.06 (1921)	.09 (1938)
October	70	1.20	4.96 (1949)	.05 (1928)
November	46	.87	2.40 (1896)	.02 (1895)
December	44	.73	2.18 (1909)	.07 (1886)
		Yearly Mean 18.46	Highest 12 Months November to October 27.40 (1943-44)	Lowest 12 Months November to October 12.25 (1888-89)

MEAN MONTHLY TEMPERATURE AND PRECIPITATION
AT RECORDING STATIONS IN THE CARBERRY MAP AREA AND AT WINNIPEG



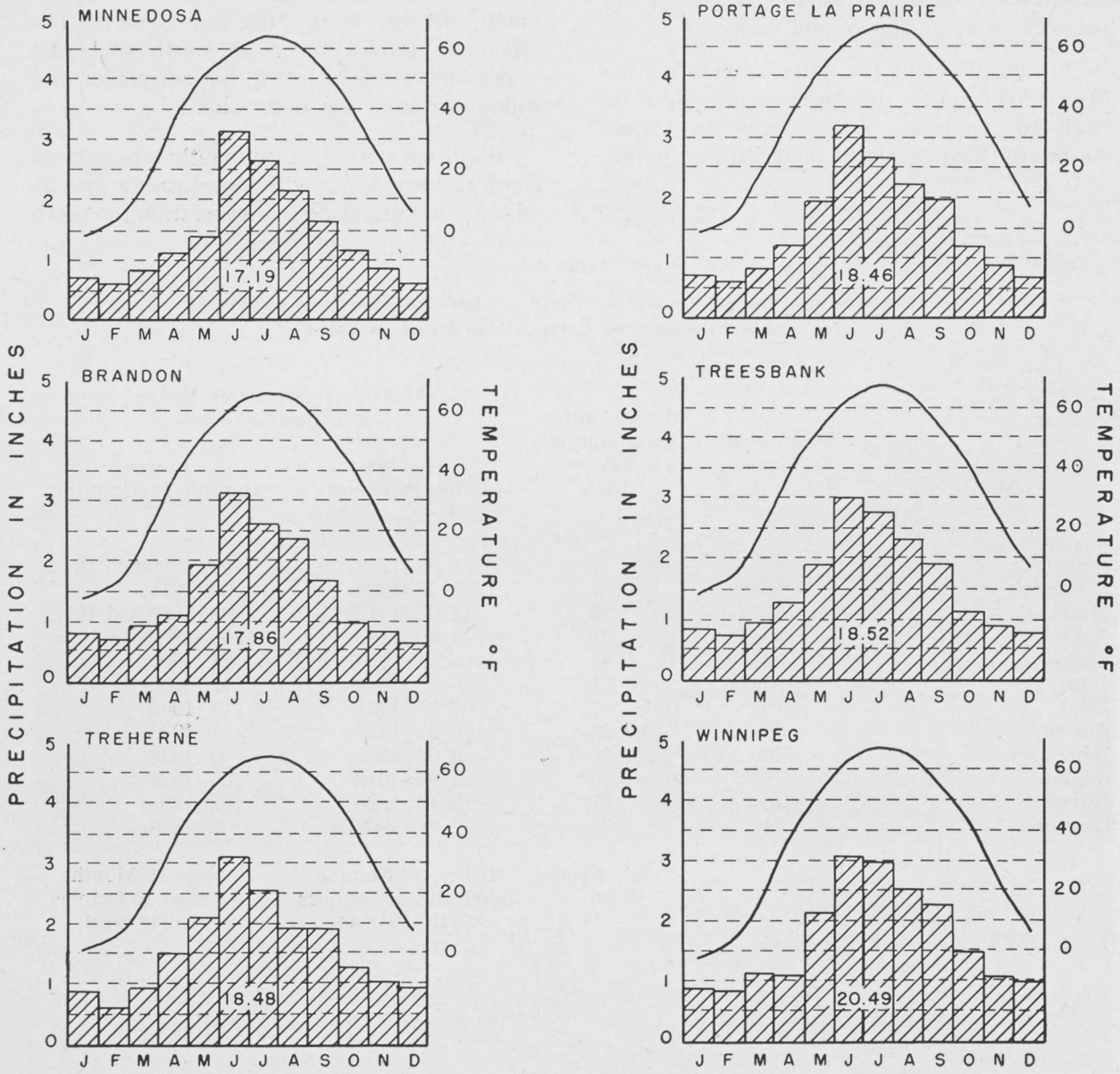


FIGURE 11

the Brandon Hills present a forested aspect, whereas the mixed vegetation on south slopes imparts a park-like appearance to the area when viewed from the south.

BRANDON LAKES LACUSTRINE PLAIN—An area covered by meadow-prairie and prairie grasses with a few aspen—balsam poplar groves in depressions and bordering stream channels.

UPPER ASSINIBOINE DELTA—A complex landscape including four distinctive plant associations. The rolling outwash plains in the western portion of the delta are covered by mixed prairie grasses and herbs. The sand dune areas are covered by scattered stands of mixed woods interspersed by prairie vegetation. The spruce and scrubby aspen-oak woods are most dense in locally humid sites whereas the prairie vegetation is predominant on south and west slopes. The lacustrine plains in the central portion of the delta are covered by tall prairie grasses and associated herbs. Local depressions in the lacustrine plains support stands of aspen and willow. The lacustrine plain bordering the Manitoba Escarpment is thickly wooded. Aspen and oak predominate in well-drained sites but many other species occur along ravines including: green ash, elm, basswood, paper birch, box elder, chokecherry, pincherry, willow, saskatoon, scarlet sumac, American plum, wild grape, climbing honeysuckle, and Virginia creeper.

LOWER ASSINIBOINE DELTA—A flat area covered by meadow-prairie and meadow grass associations intermixed with aspen, balsam poplar and willow groves of various sizes.

LOWLAND ALLUVIAL AND LACUSTRINE PLAIN—An area with sectional variation in vegetation. On the lacustrine plain south of the Assiniboine River tall prairie, meadow-prairie and meadow grass associations occur in areas with corresponding good, imperfect, and poor drainage conditions. Stream channels are bordered by woods. On lacustrine deposits the channels are bordered predominantly by oak whereas on recent alluvial deposits heavy stands of trees including elm, green ash, basswood and box elder are encountered.

FIGURE 12
The sharp Manitoba Escarpment in the foreground is heavily wooded. The aspen-balsam poplar groves interspersed by meadow and meadow-prairie are characteristic of the Lower Assiniboine Delta in the background.

WEST-LAKE AND INTERLAKE TILL PLAINS—An area covered by meadow-prairie and meadow grass associations interspersed with willow, stunted aspen and scrub oak woods. The woods occur most commonly on the micro-ridges in the till plain. Big and little blue stem are the most widespread prairie grasses. Sedges and reeds occupy the meadow sites, while cattails and reeds occur on very wet sites.

ASSINIBOINE CHANNEL—The banks, terraces and valley floor of the channel are wooded along most of its course. Tree growth is most dense along the north-facing slope. The valley terraces and bank are covered predominantly by oak, hazel and aspen poplar whereas elm, ash, box elder, balsam poplar, paper birch and cranberry are common species on the flood-plain deposits of the valley floor.

Part III.

SOILS

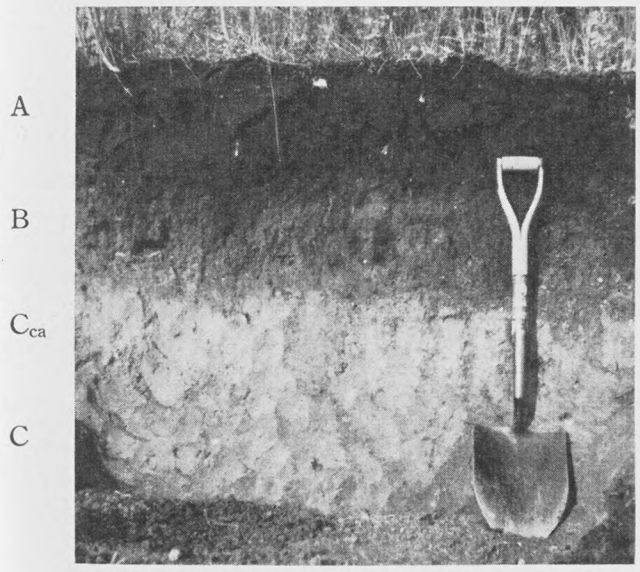
The soils that have developed under the influence of the soil-forming factors described in Part II exhibit physical characteristics which reflect their environment. Through observation of these characteristics it is possible to classify soils in accordance with their genesis or the processes involved in their formation. Such a classification scheme permits the grouping of soils into natural units. The recognition of these units is dependent on the study of the soil profiles.

A. THE SOIL PROFILE

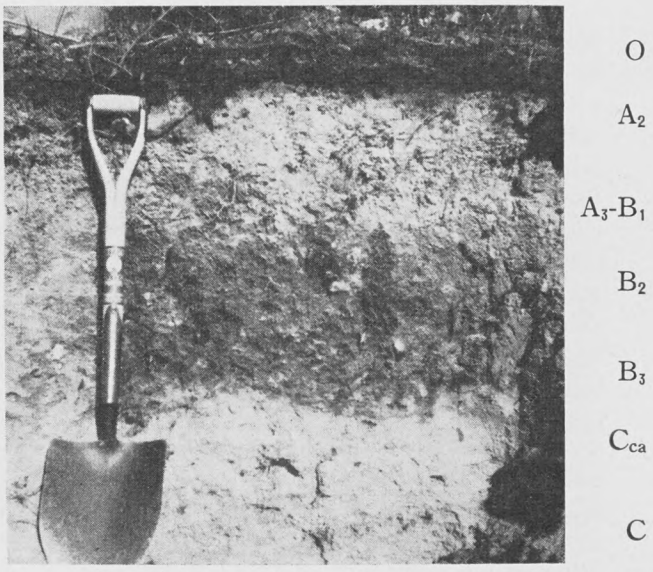
The soil profile, as viewed in vertical cross section, consists of the various soil layers to a depth of three or more feet. These layers are called soil horizons and differ from one another in one or more of the following features: color, texture, structure, consistence, reaction, concretions, intrusions, and chemical and biological composition. The main horizons are designated by the letter symbols O, A, B, C and D. For more detailed description these master horizons may be subdivided into sub-horizons, in which case they are designated as: A_1, A_2, A_3, B_1, B_2, etc. The master horizons are defined in Table 5. Examples of the use of this horizon nomenclature are given in Figure 13.

FIGURE 13

Examples of the use of Soil Horizon Nomenclature.



Black soil profile showing subdivision into soil horizons.



Grey Wooded soil profile showing subdivision into soil horizons.

TABLE 5

Definitions of Soil Horizions

O HORIZON—Organic accumulation on the surface of the soil composed of leaf litter or thin muck and peat deposits.

A HORIZON—The horizon of maximum weathering and of maximum removal of the products of weathering by downward movement of water. In grassland soils it is also the horizon of maximum accumulation of organic material.

A_1 Sub-horizon—Surface mineral layer with maximum accumulation of organic matter; dark in color.

A_2 Sub-horizon—layer of maximum leaching; light in color; prominent in most forest soils, absent in most grassland soils.

A_3 Sub-horizon—Transition layer to the B, but more like the A than B.

B HORIZON—The horizon of less intense weathering. This sub-surface horizon is characterized by: an accumulation of clay, iron, aluminum or organic matter; a blocky or prismatic structure; a color unlike that of the A or C horizons; or a combination of these features.

B_1 Sub-horizon—Transition layer to A above, but more like the B than A. Sometimes absent.

B_2 Sub-horizon—Layer of maximum development of the features that characterize the B horizon.

B_3 Sub-horizon—Transition layer to the C, but more like the B than C. Sometimes absent.

C HORIZON—The horizon of relatively unweathered material, that is similar in composition to the material from which at least a portion of the overlying solum has developed. Slight alterations in the nature of this material due to accumulation of carbonates or soluble salts, or to the process of gleization are designated by the use of subscripts.

D HORIZON—Any stratum underlying the C, or the B if no C is present, which is unlike the material from which the solum (A and B horizons) has been formed.

LETTER SUBSCRIPTS

ca—used to denote a whitish accumulation of carbonates (usually calcium carbonate) which most commonly occurs in the C horizon immediately below the B.

cs—used to denote a visible accumulation of gypsum crystals (calcium sulfate) which may occur in any horizon but most commonly in the C.

g—used to denote the process of gleization as indicated by greyish colors and red and brownish mottling. This condition is caused by oxidation and reduction processes associated with a fluctuating water table and may occur in any horizon.

B. SOIL CLASSIFICATION

The basic unit in most soil classification systems is the soil associate.* A soil associate consists of soils that are similar in physical features and chemical composition as revealed by profile characteristics. This similarity of profile features occurs only within areas of similar climate, vegetation, parent material, relief, drainage and age. Any significant variation in one or more of these soil-forming factors causes dissimilarities of profile features and the soil is classified as a different associate. Individual soil associates may occupy large continuous land areas but more commonly are associated with other soils in a complex landscape pattern.

The associated soils occurring in a landscape pattern and developed from similar parent material form a soil association*. The soil associates that constitute the association occupy different positions in the landscape and differ in profile characteristics due to the local influence of drainage and vegetation. The soil association is recognized by the characteristics of the well or imperfectly drained associates which reflect the influence of regional climate and vegetation. Where soils are developed from the same parent material but under a different climate and vegetation the better-drained associates exhibit different profile characteristics and another soil association is recognized.

When soils have similar profile characteristics but vary in some physical feature that is of importance to agriculture, the soils are classified as types or phases. Soil types are divisions based on variations in texture. Soil phases are based on external features such as topography and stoniness or the presence of an unconforming substrate.

C. SOIL MAPPING

The soils of the Carberry map area were classified into soil associations, associates, types and phases. However, as this was a reconnaissance survey it required a small mapping

*In some parts of Canada and in the United States, "the associate" is designated as "series" and the "association" as "catena".

TABLE 6

Key to Classification of the Soils in the Carberry Map Area

Key to Associations	Soil Associates						
	Acreage	% Total Area	Well Drained	Excess. Drained	Imper. Drained	Poorly Drained	Halo-morphics
A. Soil Associations in which the Dominant Soil is a Black.							
1. Soils developed on boulder till.							
(a) Till of shale, limestone and granitic rock origin.							
(1) Newdale association	....	....	....	....	....	M., SM., Sk.	....
(i) Newdale undulating phase	13,261	0.56	B.*	TB.	B-M., Deg. B-M.	CM., Deg. M.	B Sz.
(ii) Newdale smooth phase	175,181	7.25	B., Deg. B.	....	B-M.	CM., SM., Sk.	B Sz.
(b) Till predominately of limestone and granitic rock origin.							
(1) Hilton association	4,378	0.18	B.	TB.	CB.-M.	CM., SM. M.	....
2. Soils developed on thin medium-textured lacustrine deposits underlain by medium-textured till.							
(1) Beresford association	9,446	0.39	B.	....	B-M., CB-M.	M., CM., SM.	B Sz.
3. Soils developed on lacustrine deposits.							
(a) Fine-textured deposits.							
(1) Harding association							
(i) Harding clay	13,901	0.57	....	....	B-M.	M., CM., PM., SM.	....
(ii) Harding clay till substrate phase	11,699	0.48	B.	....	B-M.	M., CM., PM., SM.	....
(b) Medium-textured deposits							
(1) Carroll association	31,872	1.33	B., SzB.	....	B-M.	M., CM., SM.	....
(2) Glenboro association	1,408	.06	B.	....	....	M., Deg. M.	....
(3) Holland association	23,296	0.96	B., Deg. B.	....	B-M.	M., Deg. M., SM.	....
(4) Portage association	89,037	3.68	B., Deg. B.	....	B-M.	M.	....
(5) Wellwood association							
(i) Wellwood loams	74,163	3.06	B.	....	B-M., Deg. B-M.	Deg. M., Gwg.	....
(ii) Wellwood loams till substrate phase	7,450	0.31	B., Sz.B.	....	B-M.	M., SM.	....
(c) Intermixed medium- and coarse-textured deposits.							
(1) Holland-Stockton complex	6,323	0.26	B., Deg. B.	....	B-M.	....	....
(d) Coarse-textured deposits							
(1) Stockton association							
(i) Stockton loamy sand	345,933	14.30	B., Deg. B.	....	B-M.	M., PM.	....
(ii) Stockton fine sandy loams	137,190	4.68	B., Deg. B.	....	B-M.	M., PM.	....
(iii) Stockton fine sandy loams, till-substrate phase	2,509	0.10	B., Deg. B.	....	B-M., Deg. B-M.	M.	....
4. Soils developed on gravelly and coarse sandy deposits.							
(a) Deposits of limestone and granitic rock origin.							
(1) Agassiz association	14,669	0.61	B.	....	B-M.	....	....
(b) Deposits of shale, limestone and granitic rock origin.							
(1) Marringhurst association	29,286	1.20	B.	....	....	M., PM.	....
(2) Miniota association							
(i) Miniota sand	75,520	3.12	B., Deg. B.	....	....	M.	....
(ii) Miniota sandy loam	15,847	0.65	B.	....	B-M.	M.	....

*See Key to Symbols.

TABLE 6

Key to Classification of the Soils in the Carberry Map Area—(Continued)

Key to Associations	Soil Associates						
	Acreage	% Total Area	Well Drained	Excess. Drained	Imper. Drained	Poorly Drained	Halo-morphics
B. Soil Associations in which the Dominant Soil is a Black-Meadow or Calcareous Meadow.							
1. Soils developed on waterworked medium-textured till of limestone and granitic rock origin.							
(1) Arden association	742	0.03	B.	....	CB.-M.	M., CM., SM.	....
2. Soils developed on thin lacustrine deposits underlain by till.							
(a) Clay-textured deposits over clay-textured till.							
(1) Westbourne association	48,743	2.01	....	....	....	CM., PM., SM., Sk.	B Sz.
(b) Clay-textured deposits over medium-textured till.							
(2) Marquette association	11,520	0.47	B.	....	B-M.	CM., PM., SM., Sk.	B Sz.
(c) Medium-textured deposits over medium-textured till.							
(3) Woodlands complex	12,467	0.51	....	....	CB.-M.	CM., SM., Sk.	....
3. Soils developed on lacustrine deposits.							
(a) Fine-textured deposits.							
(1) Red River association							
(i) Red River clay	125,722	5.19	B.	....	B-M., Sz.	....	B Sz.
(ii) Osborne clay	40,832	1.69	....	....	....	M., CM., PM., SM.	....
(2) Burnside association	23,142	0.95	B.	....	B-M.	M., CM., SM.	....
(b) Medium-textured deposits.							
(1) Lakeland association	5,043	0.21	....	....	CB.-M.	CM., PM.	....
(c) Coarse-textured deposits.							
(1) Almasippi association							
(i) Almasippi sand	216,935	8.97	Deg. B.	....	Deg. B-M.	M., PM.	....
(ii) Almasippi loamy sand	304,563	12.59	....	....	B-M., Deg. B-M.	M., CM., PM., SM.	....
(iii) Almasippi clay substrate phase	12,800	0.53	....	....	B-M., Deg. B-M.	M., CM., PM., SM.	....
(2) Souris Association	9,754	0.40	B.	....	B-M.	M., CM.	....
C. Soil Associations in which the Dominant Soil is a Degrading Black.							
1. Soils developed on medium- to coarse-textured lacustrine deposits.							
(1) Firdale association							
(i) Firdale loams	49,895	2.06	Deg. B.	....	Deg. B-M.	M.	....
(ii) Firdale clay loams	14,822	0.61	Deg. B.	....	Deg. B-M.	M.	....
D. Soil Associations in which the Dominant Soil is a Degrading Black-Meadow.							
1. Soils developed on medium- to fine-texture lacustrine deposits.							
(1) Rathwell association	21,760	0.90	Deg. B.	....	Deg. B-M.	M., CM., Deg. M., Gwg., SM.	....

TABLE 6

Key to Classification of the Soils in the Carberry Map Area—(Continued)

Key to Associations	Soil Associates						
	Acreage	% Total Area	Well Drained	Excess. Drained	Imper. Drained	Poorly Drained	Halo-morphics
E. Soil Associations in which the Dominant Soil is a Rendzina.							
1. Soils developed on boulder till predominantly limestone in origin.							
(1) Isafold association	84,275	3.49	R.	....	R-M.	CM., PM., Sk., SM.	....
F. Alluvial Soils.							
1. Soils developed on highly calcareous alluvium.							
(1) Gladstone association	43,827	1.81	....	....	....	....	....
2. Soils developed on slightly calcareous alluvium.							
(a) Soil profiles moderately well developed.							
(1) Oakville association	78,412	3.25	....	....	....	....	....
(b) Soil profile weakly developed.							
(1) Riverdale association	21,709	0.91	....	....	....	....	....
G. Miscellaneous Soils.							
1. Degrading Black and Black soils developed on boulder till of limestone and granitic rock origin.							
(1) Tiger Hills-Hilton complex	11,289	0.47	Deg. B., B.	....	B-M., Deg. B-M.	M., CM.	....
2. Undifferentiated soils on river terraces and flood plain deposits.							
(1) Assiniboine complex	51,354	2.12	....	....	....	....	....
3. Eroded channels and steep slopes.							
(1) Eroded slopes	30,822	1.27	....	....	....	....	....
4. Undifferentiated muck and peat deposits; (very poorly drained).							
(1) Marsh	62,848	2.60	....	....	....	....	....
Lakes	53,555	2.21	....	....	....	....	....
	2,419,200	100.00					

**Key to Associate Symbols.*

Well Drained

B.....Black
Deg. B.....Degrading Black
R.....Rendzina
SzB.....Solonetzic Black

Excessively Drained

Tb.....Thin Black

Imperfectly Drained

B-M.....Black-Meadow
CB-M.....Calcareous Black-Meadow
Deg. B-M.....Degrading Black-Meadow
R-M.....Rendzina-Meadow
SzB-M.....Solonetzic Black-Meadow

Halomorphics

B Sz.....Black Solonetz

Poorly Drained

M.....Meadow
CM.....Calcareous Meadow
SM.....Saline Meadow
PM.....Peaty Meadow
Deg. M.....Degrading Meadow
Gwg.....Grey Wooded Glei
Sk.....Solonchak

scale to cover the large area of the map sheet, and it was impossible to show each individual kind of soil as a unit. For this reason the soils were grouped into mapping units which permitted the presentation of the most detailed information possible under the mapping scale. The soil association was the primary mapping unit utilized in the preparation of the soil map. Where single associates, types or phases occupy large continuous areas they are shown separately. Where soils have been developed from intermixed parent materials they were mapped as a complex.

In conducting this survey a traverse was made along each road allowance, thus giving lines of traverse one mile apart, and permitting the observation of at least two sides of each quarter section. Foot traverses inside the sections were made only if some important detail was required which could not be obtained from the ordinary lines of traverse. Along the lines of traverse the soils were examined at from one-quarter to one-half mile intervals, or more frequently if closer inspection was indicated.

D. CLASSIFICATION AND DESCRIPTION OF THE SOILS OF THE CARBERRY MAP AREA

A key to the soils of the Carberry map area is presented in Table 6. The soil associations are arranged into groups on the basis of the genetic type of the dominant soil associate and on the kinds of materials from which the associations have been developed. The associated genetic soil types that occur in each association are listed by soil drainage classes. A description of the profile features that charaterize each of the genetic soil types recognized in the Carberry map area is given in Table 7.

The soil association descriptions are presented according to their order in the key. A description of the texture, parent material, topography, drainage and vegetation is presented for each association. A detailed profile description of the dominant associate is given and the occurrence and distribution of other associated genetic types are noted. The fertility, land-use pattern, problems and recommended cultural practices are described for each soil association.

TABLE 7

Description of Genetic Soil Types Occurring in the Carberry Map Area

WELL-DRAINED SOILS

BLACK—Soils which have a thick, very dark grey to black A horizon that is high in organic matter, granular in structure, friable, and neutral in reaction; and a weakly to moderately well-developed, brownish B horizon with very little or no clay accumulation, neutral in reaction and with sub-angular blocky (nutty) aggregates which may cohere in weak column-like structures. A distinct whitish layer of lime carbonate accumulation (Cca horizon) generally occurs below the B horizon and grades into the relatively unaltered parent material.

SOLONETZIC BLACK—Soils with similar profile characteristics to the Black except that these soils have prismatic or columnar structure in the lower A and in the B horizons. In contrast to the Black Solonetz soil the Solonetzic Black has no visible concentration of salts below the B horizon.

DEGRADING BLACK—Soils which have a thin, partially decomposed leaf mat (O horizon); a mottled, dark grey to grey A horizon (or weakly differentiated dark grey, A_1 horizon and grey A_2 horizon), granular to weakly platy in structure, friable, and slightly acid in reaction; and a moderately well-to strongly developed, brown B horizon with sub-angular blocky to blocky structure, and slightly acid reaction. A distinct whitish layer of lime carbonate accumulation (Cca horizon) usually occurs below the B horizon and grades into the relatively unaltered parent material.

RENDZINA—Soils developed from parent material containing over 40% lime carbonate. The soil has a dark grey to black A horizon which is thin in comparison with the Black soil and is granular in structure, alkaline in reaction and usually contains free lime carbonate. The A horizon grades sharply into the highly calcareous parent material.

EXCESSIVELY DRAINED SOILS

THIN BLACK—Soils developed under locally dry conditions. The A horizon is thinner than that of the associated Black soils, granular in structure, friable and neutral to slightly alkaline in reaction. The B horizon, where present, is weakly developed and mildly alkaline in reaction. A weak lime carbonate accumulation usually occurs in the upper portion of the C horizon.

TABLE 7

Description of Genetic Soil Types Occurring in the Carberry Map Area—(Continued)

IMPERFECTLY DRAINED SOILS

BLACK-MEADOW INTERGRADE—Soils that are transitional between the Black and the Meadow types. They have a thick, very dark grey to black A horizon that is granular in structure, friable and neutral to slightly alkaline in reaction. The B horizon is often absent or consists of a thin transitional layer between the A and C horizons. The feebly gleyed C horizon is mottled with iron and contains free lime carbonate.

CALCAREOUS BLACK-MEADOW INTERGRADE—Soils that are transitional between the Black and the Calcareous Meadow types. Similar to the Black-Meadow Intergrade but contains free lime carbonate in the A horizon and is alkaline in reaction. The B horizon is usually absent.

DEGRADING BLACK-MEADOW INTERGRADE—Soils that are transitional between the Degrading Black and the Meadow types. A thin, partially decomposed leaf mat (O horizon) overlies a slightly to moderately leached A horizon, which may be blotched or weakly differentiated into a dark grey A_1 horizon and a grey A_2 horizon. This horizon is granular to platy in structure and slightly acid in reaction. A greyish brown B horizon is moderately well developed and is sub-angular blocky to blocky in structure and neutral in reaction. The C horizon and often the lower portion of the B horizon are weakly mottled with iron and contain free lime carbonate.

RENDZINA-CALCAREOUS MEADOW INTERGRADE — Soils which are transitional between the Rendzina and calcareous Meadow soils. The soil profile closely resembles that of a Rendzina soil with the exception that the surface or A horizon is always calcareous and the C horizon is weakly to moderately gleyed.

POORLY DRAINED SOILS

MEADOW—Gleysolic soils with a black to very dark grey A horizon which is usually high in organic matter, granular in structure, friable, and slightly alkaline to neutral in reaction. This horizon grades into a gleyed C horizon which is mottled with iron and contains free lime carbonate.

CALCAREOUS MEADOW—Similar to Meadow soil but contains free lime carbonate in the A horizon and is alkaline in reaction.

SALINE MEADOW—Similar to the Meadow soil but contains soluble salts in the A horizon.

PEATY MEADOW—Similar to the Meadow soil but with a surface layer of up to 10 inches of peat or muck.

DEGRADING MEADOW—Soils developed under alternating wet and dry conditions. They have a well-decomposed leaf or sod mat (O horizon); an iron stained, dark grey to grey blotched A horizon (or a thin, dark grey A_1 horizon and a weakly developed iron stained A_2 horizon), granular in structure, and may be slightly acid, neutral, or slightly alkaline in reaction; a greyish brown B horizon that is weakly to moderately well developed, coarse granular to sub-angular blocky in structure, neutral to slightly alkaline in reaction and iron stained. The gleyed C horizon is strongly iron stained and contains free lime carbonate.

GREY WOODED GLEY—Soils developed under alternating wet and dry conditions. They usually have a thin, dark grey A_1 horizon that is granular in structure and slightly acid in reaction; a well- developed, grey A_2 horizon that is platy in structure, slightly acid in reaction, and iron stained; transitional, brownish grey A_3 and B_1 horizons; a well-developed, dark greyish brown B_2 horizon with a clay concentration, blocky in structure, slightly acid in reaction, and iron stained. This horizon grades through a transitional B_3 horizon into the gleyed C horizon which is strongly mottled with iron and contains free lime carbonate.

SOLONCHAK—Soils with a high concentration of soluble salts throughout. Profile development is absent or limited to the formation of a thin, dark grey A horizon. The C horizon contains free lime carbonate and is iron stained.

HALOMORPHIC SOILS

BLACK SOLONETZ—Soils developed from saline parent material through the processes of desalinization and leaching. They have a thin, dark grey to black A horizon which may contain blotches of lighter colored material due to leaching, and is granular, friable, and neutral in reaction; a thick, dark grey to dark greyish brown B horizon, prismatic to coarse blocky in structure, very hard when dry, and neutral to slightly alkaline in reaction. The C horizon contains a layer of lime carbonate accumulation below the B horizon and a concentration of soluble salts deeper in the profile.

SOIL ASSOCIATIONS IN WHICH THE DOMINANT SOIL IS BLACK

NEWDALE ASSOCIATION (188,442 acres)

The Newdale loam to clay loam soils are developed on medium-textured, moderately calcareous boulder till of mixed shale, limestone and granitic rock origin. Stones are present throughout the Newdale soils, but constitute a problem to cultivation only in areas of rough topography and in areas bordering stream channels.

The topography of the Newdale till plain is irregular and varies from nearly level to moderately undulating. Soil drainage is variable. Run-off waters from the knolls and ridges either accumulate in enclosed depressions

or drain away through meandering, shallow channels. The vegetation is prairie grasses intermixed with aspen groves. Tall prairie grasses predominate on south- and west-facing slopes; aspen and oak occur on north- and east-facing slopes; and aspen, balsam poplar and willows grow around the marshy depressions.

Two topographic phases of the Newdale association occur in this map area. These divisions are shown on the soils map and will be described as: the undulating phase, and the smooth phase.

(i) *Newdale undulating phase* (13,261 acres)

The topography of the Newdale undulating phase varies from irregular moderately sloping to nearly level, but is characteristically irregular gently sloping. As the topography is irregular and undrained depressions are numerous, the soils may vary considerably within the same field. The typical soils of the Newdale undulating phase, which are found in well-drained positions on gentle slopes, are Black soils and may be described as follows:

A —Very dark grey loam to clay loam (6 to 10 inches thick); finely granular; friable when moist, hard when dry; neutral in reaction.

B —Dark greyish brown coatings on fine blocky aggregates which are brown inside; clay loam to heavy clay loam in texture (5 to 8 inches thick); aggregates arranged in weak columnar structures; firm when moist, hard when dry; neutral to slightly alkaline in reaction. Grades sharply into:

Cca–Very pale brown loam to clay loam, lime carbonate accumulation horizon of variable thickness. Fades gradually into:

C —Light brownish grey boulder till of loam to clay loam texture; amorphous; weakly cemented when dry, plastic when wet; mildly alkaline, moderately calcareous.

Thin Black soils occur in association on top of the more prominent knolls. Black-Meadow and degrading Black-Meadow soils are found as narrow bands around the edge of the depressions or along the margins of broad, shallow draws. The soils which occur in depressions and shallow draws are of four distinct types: Meadow, Calcareous Meadow, Saline Meadow and Degrading Meadow associates. These Meadow soils often are developed on modified parent material in which a thin deposit of lacustrine or alluvial sediment occurs over the boulder till.

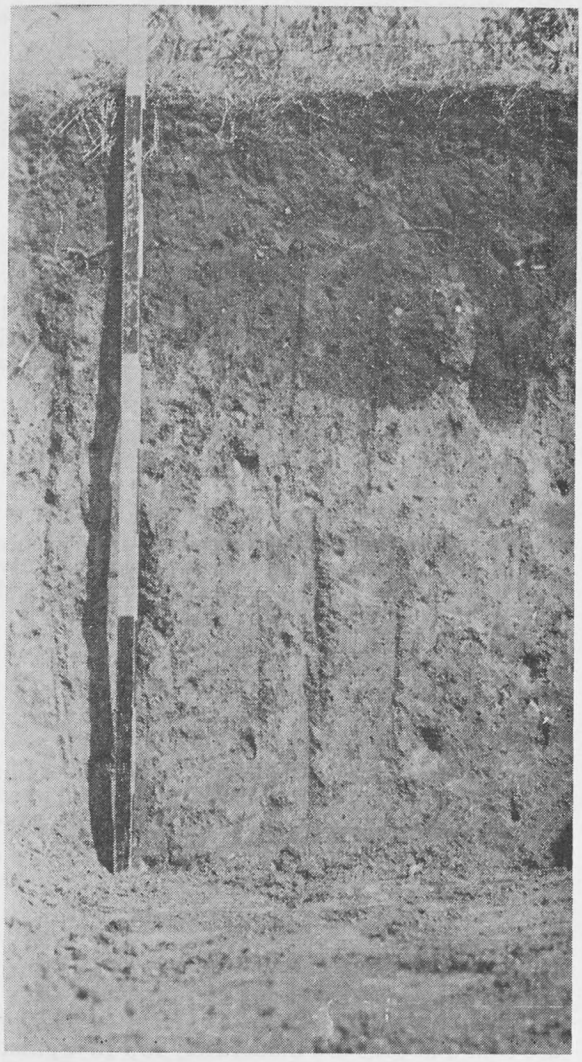
(ii) *Newdale smooth phase* (175,180 acres)

The topography of the Newdale smooth phase is relatively smooth in comparison to the undulating phase, however, there is notable relief in the form of low knolls and slight depressions. As surface run off and internal drainage are slow, a large percentage of the soils are imperfectly to poorly drained. The dominant Black-Meadow soil is described on page 39.

Associated Black soils occur on the sharp knolls. Small areas of Degrading Black and degrading Black-Meadow soils have developed under woodland invasion on northern and eastern slopes. The soils in the poorly drained positions are largely Calcareous Meadow and Saline Meadow types although Meadow and Degrading Meadow soils occur to a limited extent.

Agriculture: The better-drained Newdale soils are naturally fertile and are well suited to the production of grain and forage crops. They have good water-retention capacity, neutral to slightly alkaline reaction, and high organic matter content.

The agricultural value and adaptability of any individual parcel of land is dependent on the local topography as it affects the distribution of the soil associates. Areas with smooth topography and relatively few sloughs and potholes are suited to extensive grain farming. However, over much of the Newdale soil area in this map sheet the topography is irregular and the fields are broken by numerous sloughs and potholes. In these areas, cultivated fields are often small and irregular, and the percentage of arable land is lower. A mixed-farming enterprise provides for a better utilization of the soils in these areas.



A —Very dark grey loam to clay loam (4 to 8 inches thick); finely granular; friable when moist, hard when dry; slightly alkaline in reaction.

B —Very dark greyish brown loam to clay loam (1 to 4 inches thick); subangular blocky; friable when moist, hard when dry; alkaline in reaction.

Cca–Very pale brown loam to clay loam, carbonate accumulation of variable thickness. Fades gradually into:

C —Light yellowish brown loam to clay loam boulder till; amorphous; weakly cemented when dry, plastic and sticky when wet; some iron staining and may contain gypsum crystals.

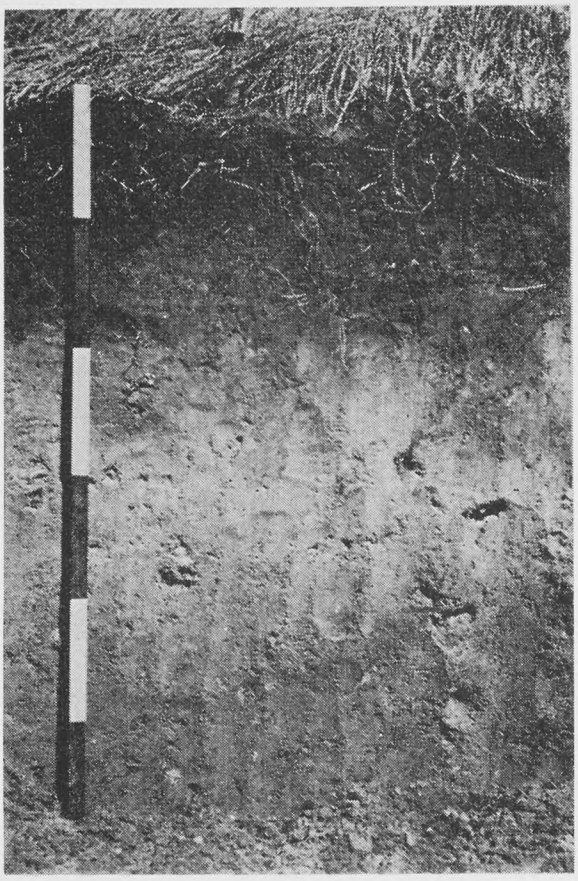
FIGURE 14

Soil profile of the Black-Meadow member of the Newdale association. (Stick interval—12 inches.)

HILTON ASSOCIATION (4,378 acres)

The Hilton loam to clay loam soils are developed on highly calcareous boulder till of predominantly limestone and granitic rock origin. Stones occur throughout the Hilton soils and are very numerous in local areas.

The topography of the till plain is irregular gently sloping to nearly level. Soil drainage is dominantly good. The runoff water from the low hills and gentle slopes accumulates in widely scattered depressions or drains away through meandering runways. The vegetation is mixed prairie grasses and associated herbs on the better-drained sites and meadow grasses in the poorly drained sites. The dominant, well-drained soil is a Black and may be described as follows:



A —Very dark grey loam to clay loam (4 to 8 inches thick); finely granular; friable when moist, slightly hard when dry; mildly alkaline in reaction.

B —Dark greyish brown loam to clay loam (1 to 4 inches thick); granular; firm when moist, hard when dry; alkaline in reaction and may be weakly calcareous.

Cca–Very pale brown loam to clay loam (5 to 9 inches thick); granular; friable when moist, slightly cemented when dry, moderately alkaline and strongly calcareous.

C —Very pale brown loam to clay loam boulder till; pseudo-granular; friable when moist, hard when dry; moderately alkaline and strongly calcareous.

FIGURE 15
Soil profile of Black member of the Hilton association. (Stick interval—6 inches.)

The Black soils on convex slopes have A horizons usually not more than six inches thick, whereas those on concave slopes have A horizons up to ten inches thick. The associated members include Thin Black, calcareous Black-Meadow, Meadow, Calcareous Meadow and Saline Meadow soils. The Thin Blacks are developed on the more prominent knolls. The calcareous Black-Meadow soils occur in imperfectly drained positions between the well and poorly drained soils. The Meadow and Saline Meadow soils occur in the depressions.

Agriculture: The natural fertility of the Hilton soils is moderate to low. The soils contain sufficient calcium carbonate to affect the availability of some plant nutrients and to cause physiological drought. The surface horizons are thin and soils are moderately low in organic matter. However, the soils have fairly good water-retention capacity and with suitable fertilization will produce good yields of grain and forage crops in years of high rainfall.

The Hilton soils in this map area are utilized mainly for grain production. Small herds of cattle are maintained on most farms and are pastured on the soils that are very stony or on adjacent areas of rough topography. Water-erosion control measures are a necessity on cultivated fields with sloping topography.

BERESFORD ASSOCIATION (9,446 acres)

The Beresford soils are developed on a thin, medium-textured mantle of lacustrine deposits

which overlie medium-textured boulder till. The surface soil is clay loam in texture. Stoniness is variable. Where the surface lacustrine mantle is relatively thick, few stones are found; but where it is thin, stones are sufficiently numerous to interfere with cultivation.

The topography is nearly level. Surface runoff is slow and internal drainage is slightly impeded by the underlying boulder till so that most of the soil area is moderately well to imperfectly drained. The native vegetation on the better-drained soils is dominantly tall prairie grasses, whereas on the poorly drained soils, meadow grass associations occur interspersed with some willow and balsam poplar.

The dominant soils are Blacks which are moderately well-drained and appear to be slightly solonetzic. A representative profile description of this soil is given below:

A —Very dark grey clay loam (9 to 14 inches thick); granular; friable when moist, slightly hard when dry; neutral in reaction.

AB–Very dark greyish brown clay loam (1 to 3 inches thick); weakly prismatic, subangular blocky; friable when moist, hard when dry; neutral in reaction.

B —Brown clay loam (4 to 12 inches thick); weakly prismatic, strongly subangular blocky; neutral to mildly alkaline in reaction; contains gypsum as pseudomycelium in the lower portion.

Dca–Very pale brown, clay loam boulder till (4 to 8 inches thick); laminar; firm when moist, hard when dry; moderately alkaline; contains gypsum crystals; weakly gleyed.

D —Very pale brown clay loam boulder till; pseudogranular; very firm when moist, very hard when dry; moderately alkaline; strongly calcareous; weakly iron stained.

The A and B horizons of the Black soil are developed in the lacustrine mantle and their thickness is often restricted by the calcareous boulder till substrate. The associated members include Black-Meadow, Meadow, Calcareous Meadow and Saline Meadow soils. The Black-Meadow soils often are solonetzic and have a prismatic-structured A horizon and have brown, clay-coated, prismatic aggregates in the B horizon. These solonetzic soils occur adjacent to poorly drained areas. The Meadow, Calcareous Meadow, and Saline Meadow soils occur in the depressions.

Agriculture: The dominant, better-drained Beresford soils are good to excellent for grain and forage production. They are highly fertile as they have neutral reaction, a good reserve of organic matter, fair to good aeration, and favorable water-retention capacity. The fertility of the poorly drained soils is variable due to the varying content of calcium carbonate and toxic salts.

The Beresford soils are utilized almost entirely for grain production but are equally suited to forage crops. The soils are moderately resistant to wind erosion, and water erosion is not a problem as the topography is nearly level. Sufficient stones to interfere with cultivation occur in local areas. Runoff water may accumulate in low areas during the spring thaw and after heavy summer rains, causing delay in seeding or a setback in crop growth.

HARDING ASSOCIATION (25,600 acres)

The Harding clay soils are developed on shallow lacustrine clay deposits, which are underlain at varying depths by moderately calcareous glacial till. Where the glacial till is encountered within 30 inches of the surface, the soils are classified as Harding clay, till-substrate phase.

The topography varies from nearly level to gently sloping, depending on the thickness of the clay deposit overlying the boulder till and the occurrence of drainage channels. Surface drainage varies in accordance with the topography, but internal percolation is slow throughout the soil area. The native vegetation is dominantly mixed prairie and meadow grasses, with aspen and willow growing along drainage channels. Salt-tolerant grasses and herbs occur in some depressions.

The soils of the Harding association are shown on the soil map and will be described as: (i) Harding clay, and (ii) Harding clay, till-substrate phase.

(i) *Harding Clay* (13,901 acres)

The normal Harding clay soils are developed from clay deposits of more than 30 inches in thickness, so that the underlying till substrate has not directly affected soil profile development. The topography is smooth with long, very gentle slopes terminating in small meadows or sloughs. Steeper slopes are restricted to the banks of drainage channels which dissect the area and carry surface runoff waters to the Assiniboine River. Surface drainage is fair to good, but internal drainage is slow and the soils are predominantly moderately well- to imperfectly drained.

Most of the better-drained Harding soils exhibit solonetzic characteristics and the well-developed Solonetzic Black member may be described as follows:

A —Very dark grey clay (4 to 10 inches thick); granular; friable to firm when moist, hard when dry; neutral to mildly alkaline in reaction.

AB –Dark grey clay (1 to 3 inches thick); prismatic, subangular blocky; firm when moist, hard when dry; mildly alkaline in reaction.

B_2 —Dark grey to dark greyish brown clay (3 to 5 inches thick); prismatic, strong subangular blocky; firm when moist, very hard when dry; mildly alkaline in reaction.

B_3 —Dark greyish brown clay (2 to 3 inches thick); weakly fine prismatic, subangular blocky; firm when moist, very hard when dry; mildly alkaline in reaction, contains some calcium carbonate.

Cca–Greyish brown to olive grey clay (6 to 12 inches thick); massive; sticky and plastic when wet, very hard when dry; moderately alkaline, moderately calcareous; weakly iron stained and contains some gypsum crystals.

C —Dark greyish brown to olive clay; massive; sticky and plastic; moderately alkaline, slightly calcareous; iron stained and contains gypsum crystals.

A prominent feature of these soils is the deep tonguing of the surface horizons into the subsoil. Associated soils include: Black-Meadow, Meadow, Calcareous Meadow, Peaty Meadow, and Saline Meadow soils. The Black-Meadow soils constitute a large portion of the association area. The Meadow and Calcareous Meadow types are the most common of the poorly drained soils. The acreage of the Peaty Meadow and Saline Meadow soils is small.

(ii) *Harding Clay, till-substrate phase* (11,699 acres)

The Harding clay, till-substrate phase soils are developed from clay deposits of less than 30 inches in thickness, overlying moderately calcareous boulder till. These soils occur as a transitional belt between the Harding clay soils and the Newdale soils developed from boulder till. The topography ranges from the smooth, very gently sloping topography of the Harding clay soils on the south to the undulating topography of the Newdale soils on the north. The landscape slopes gently to the south and a number of drainage channels dissect the area and provide good surface drainage.

The soils are similar in profile features to those of the normal Harding clay, but are not as strongly solonetzic. Where the lacustrine clay deposit is very thin, the solum is partially developed from the underlying boulder till. Scattered surface stones occur throughout the area but do not hinder tillage operations.

Agriculture: The Harding soils are naturally fertile and produce consistently high yields of grain and forage crops. They have a favorable neutral to mildly alkaline reaction, a high moisture-retention capacity, moderately good drainage, and a good reserve of organic matter.

The Harding soils are being utilized almost entirely for grain production, but are equally suited to forage crops. Small herds of cattle are kept on some farms to utilize rough, stony or wet land occurring along deeply cut drainage channels. However, a high percentage of the land is arable and large fields suited to power equipment can be farmed.

The main agricultural problems of these soils arise from their clay texture and slow internal drainage. Tillage operations are more costly than on coarser-textured soils and are hindered by the sticky consistence of the soil during excessively wet periods. Soil salinity tends to reduce yields in some local areas.

CARROLL ASSOCIATION (31,812 acres)

The Carroll soils are developed on medium-textured lacustrine sediments which are seldom

more than ten feet thick. The surface texture ranges from very fine sandy loam to clay loam with silty clay loam textures predominant.

The topography is nearly level. Soil drainage is imperfect to moderately good over a considerable area due to a combination of slow surface runoff from the level topography and impeded internal drainage caused by the slowly permeable nature of the underlying till. A few shallow runways provide better surface drainage to a portion of the area and well drained soils occur along these channels. The native vegetation is tall prairie grasses and associated herbs. Meadow grasses grow in poorly drained sites.

The well-drained representative Carroll soil is a Black and has the following profile characteristics:

A —Very dark grey silty clay loam (8 to 12 inches thick); granular; friable when moist, slightly hard when dry; neutral to slightly alkaline in reaction.

B —Brown silty clay loam (6 to 10 inches thick); weakly medium columnar, subangular blocky; firm when moist, hard when dry; mildly alkaline in reaction.

Cca–Very pale brown silty clay loam (8 to 11 inches thick); finely granular; friable when moist and dry; moderately alkaline and strongly calcareous.

C —Very pale brown silty clay loam; pseudo-fine granular; friable when moist, hard when dry; moderately alkaline and strongly calcareous.

The associated soils include: Black-Meadow, Solonetzic Black, Meadow, Calcareous Meadow, and Saline Meadow soils. The Black-Meadow and Solonetzic Black soils constitute a large portion of the association area. The Meadow and Saline Meadow soils constitute a smaller but significant acreage in the soil area.

Agriculture: The better-drained Carroll soils are naturally fertile and are suited to all crops common to the region. They have a good reserve of organic matter, neutral to mildly alkaline reaction, good water-retention capacity, and excellent tilth.

The Carroll soils presently are utilized almost exclusively for grain production. The coarser-textured soils are susceptible to wind erosion as the soil aggregates pulverize readily. In local areas where topography is sloping, much of the top soil has been removed through water erosion. With good soil management, the Carroll soils in areas with level topography may be maintained at a high level of productivity. Artificial drainage is needed in some meadow and salinized areas to remove surface waters and improve the productivity of the soils.

GLENBORO ASSOCIATION (1,408 acres)

The Glenboro very fine sandy loam to clay loam soils are developed on medium-textured lacustrine deposits underlain by stratified sand. The medium-textured deposit is thin and the sand substrate is generally encountered within three to four feet.

The topography is smooth and level. Soil drainage is good over nearly all of the area due to rapid internal percolation. The native vegetation is dominantly tall prairie grasses and associated herbs. Some aspen occur around the few depressions, and waxberry is commonly encountered on the level plain.

Black soils constitute almost the entire association and have the following profile features:

A —Very dark grey to very dark greyish brown loam (12 to 20 inches thick); granular; friable when moist, slightly hard when dry; neutral in reaction.

B_2—Brown loam (4 to 8 inches thick); fine subangular blocky; firm when moist, hard when dry; neutral in reaction.

B_3—Pale brown very fine sandy loam (3 to 5 inches thick); weakly fine subangular blocky; firm when moist, hard when dry; slightly alkaline in reaction.

Cca–Very pale brown loamy fine sand (5 to 10 inches thick); granular; friable when moist, slightly hard when dry; moderately alkaline and strongly calcareous.

D —Very pale brown fine sand to sand; stratified; loose; mildly alkaline and slightly calcareous.

Associated soils include a small acreage of Meadow and Degraded Meadow soils.

Agriculture: The Glenboro soils are naturally fertile. They have thick surface or A horizons with a good reserve of organic matter, neutral reaction, and moderately good water-retention capacity.

The chief soil problem is wind erosion as the soil aggregates pulverize readily. Corn planted in rows at 10 to 12 foot intervals is a method of erosion control during the fallow year. In dry years crop yields are reduced as the water-retention capacity of the sandy subsoil is low. Ground water is present at 15 to 20 feet and trees and deep-rooted legumes grow well once they have become established.

HOLLAND ASSOCIATION (23,296 acres)

The Holland very fine sandy loam to clay loam soils are developed on medium-textured lacustrine deposits. These deposits are relatively thick over most of the soil area, but adjacent to the sandy Stockton soils the deposits are thinner and in some cases the underlying sand may be encountered within three to four feet.

The topography is level, but at intervals the smooth plain is dissected by ravines which drain into either the Assiniboine or Boyne rivers. Along these runways, soil drainage is good, but in areas with level topography surface runoff is slow and water may accumulate in the depressions during wet seasons. The native vegetation is primarily tall prairie grasses and herbs, but aspen occur around depressions and aspen and oak woods occur along ravines.

The dominant Black soil of the Holland association may be described as follows:

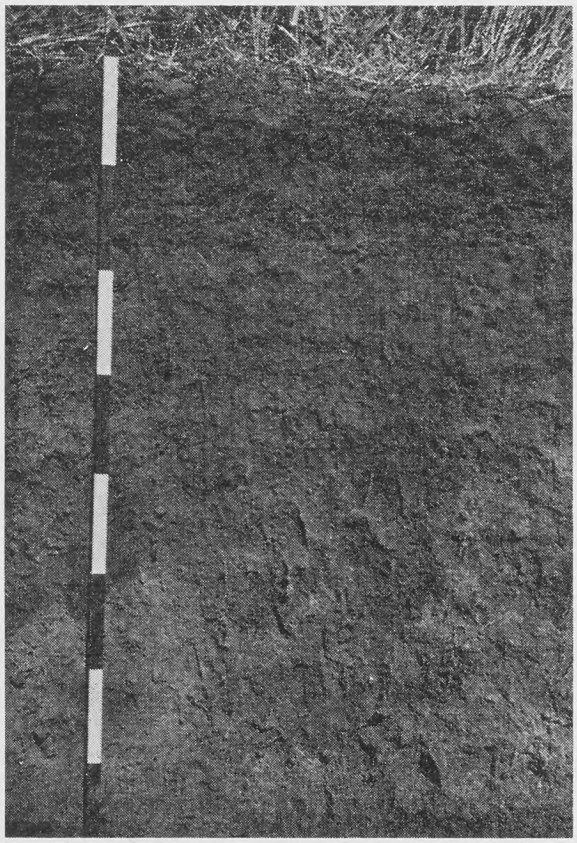


FIGURE 16
Soil profile of the Black member of the Holland association. (Stick interval—6 inches.)

A —Very dark grey loam (7 to 12 inches thick); coarse column-like structures break to fine granular aggregates; friable when moist, slightly hard when dry; neutral in reaction.

AB —Dark greyish brown loam (2 to 3 inches thick); coarse column-like structures break to granular aggregates; friable when moist, slightly hard when dry; neutral to slightly acid in reaction.

B_2—Greyish brown loam to clay loam (4 to 7 inches thick); fine subangular blocky; friable when moist, hard when dry; slightly acid in reaction.

B_3—Brown to light olive loam (3 to 12 inches thick); weakly fine subangular blocky; very friable when moist, slightly hard when dry; neutral in reaction.

Cca—Pale brown to pale olive loam (5 to 12 inches thick); granular; very friable when moist, weakly cemented when dry; mildly alkaline and moderately calcareous.

C —Pale olive to light olive brown loam; laminar; mildly alkaline and moderately calcareous.

Associated soils include Degrading Black, Black-Meadow, Meadow, Degrading Meadow and Saline Meadow soils. The Degrading Black soils occur along the wooded ravines. Black-Meadow soils are common in finer-textured Holland soil areas, especially where the topography is flat. The type of soil that occurs in the low positions varies with local conditions. Meadow soils are most common and occupy depressions where internal drainage is poor. Degrading Meadow soils occur in depressions in which internal drainage is fair to good. Saline Meadow soils occur along channels which carry runoff and seepage waters from the higher land area to the south.

Agriculture: The well-drained Holland soils are highly fertile. They have thick surface or A horizons with a good reserve of organic matter, neutral reaction, and moderately good to good moisture-retention capacity.

Although the predominant grain farming system is profitable on these soils, soil drift banks and light-colored slopes are mute evidence of improper management. Wind erosion has occurred principally on the coarser-textured soils, while sheet erosion has been most severe on slopes adjacent to ravines. Contour farming of sloping land and the inclusion of forage crops in the rotation system will help to prevent further soil erosion. The soils are well adapted to grasses and legumes and are excellent for tree shelter belts.

PORTAGE ASSOCIATION (89,037 acres)

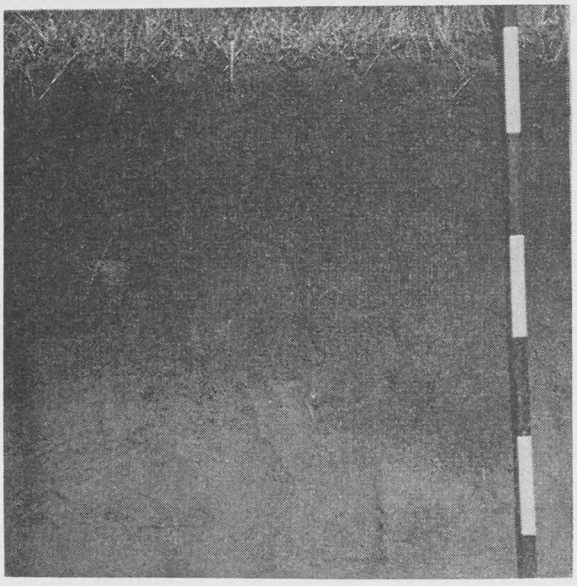
The Portage soils are developed on a medium- to fine-textured alluvial fan to the north and east of Portage la Prairie. The surface textures vary from very fine sandy loam on the levees to silty clay in the depressions, but are characteristically very fine sandy loam to silty clay loam. On some of the levees and on several ridges within the fan, the soils are coarser-textured and have been mapped as the Almasippi association. The alluvial sediments are underlain by lacustrine clay, except in a small strip bordering the Isafold association where they are underlain with till and water-worked till. The thickness of these alluvial deposits over the unconforming substrate varies from two to six or more feet.

The topography is generally smooth, very gently sloping but appears undulating in areas containing well developed levees and meandering channels. Soil drainage over the greater part of the area is good as numerous drainage channels facilitate surface runoff and the soils are very permeable. Where the terrain is nearly level and the clay substrate is close to the surface, both runoff and internal drainage is impeded. The original native vegetation on the Portage soils was tall prairie, meadow-prairie and associated meadow grasses and herbs. Since settlement, the vegetative cover has been largely replaced by agricultural crops. Some native trees such as oak, elm, ash, maple and basswood are found near the Assiniboine and Whitemud rivers and on some levees of several intermittent stream channels. A description of the representative Black soil is given on page 46.

The Black, very fine sandy loam soils on the levees lack the iron staining of the subsoil. Associated soils include Degrading Black, Black-Meadow and Meadow soils. The Degrading Black soils occur in narrow strips along the Assiniboine and Whitemud rivers. The Black-Meadow and Meadow associates constitute a small acreage of the Portage soils and are usually slightly finer in texture than the Black associates. These soils have "A" horizons that are 12 or more inches thick, even though drainage is imperfect to poor.

Agriculture: The Portage soils are naturally, highly fertile and produce good to excellent yields of regional crops. They have an abundant supply of organic matter, a moderate to high moisture-retention capacity, and a favorable reaction for crop growth.

There are few natural problems associated with the Portage soils. However, wind erosion can become serious, especially on the coarser-textured soils on the ridges. Special crops,



A —Very dark grey silty clay loam (12 to 20 inches thick); medium granular; friable when moist, slightly hard when dry; porous; slightly alkaline in reaction. Blends gradually into:

B —Greyish brown silty clay loam (6 to 10 inches thick); medium granular; friable when moist, slightly hard when dry; moderately porous; slightly alkaline and slightly calcareous. In most cases, this horizon is a transition between the "A" and "C" and is characterized only by color; in some soils the horizon is absent. Fades into:

Cca–Very pale brown silty clay loam (6 to 12 inches thick); fine granular; friable when moist, weakly cemented when dry; moderately porous; moderately alkaline and strongly calcareous; slightly iron stained.

C —Pale brown silty clay loam; fine granular; friable when moist, slightly hard when dry; moderately porous; moderately alkaline and moderately calcareous; slightly iron stained.

FIGURE 17
Soil profile of the Black member of the Portage association. (Stick interval—6 inches.)

such as peas, potatoes and beets, have been very successfully grown on these soils. They are well suited to diversified agriculture when local markets have increased.

WELLWOOD ASSOCIATION (81,613 acres)

The Wellwood soils are developed on medium-textured lacustrine deposits which normally overlie stratified sand at from 30 to 50 inches below the surface. Small portions of the Wellwood soils, occurring adjacent to areas of Newdale and Arden soils, are underlain by moderately calcareous boulder till at shallow depths below the solum. These soils were classified as Wellwood, till-substrate phase. The surface texture of the Wellwood soils varies from very fine sandy loam to clay loam but is predominantly loam.

The smooth, level topography, which is a striking landscape feature, is interrupted where drainage channels have been cut by runoff waters, and where the underlying sandy deposits shelve out to form islands of sandy soils above the general level of the terrain. Drainage is dominantly good, due to the high permeability of the soil material, but is impeded in areas with a boulder till substrate close to the surface. The native vegetation is tall prairie grasses and associated herbs with aspen and willow groves in local depressions and on the imperfectly drained soils of the till-substrate phase.

The soils of the Wellwood association are shown on the soil map and will be described as:

(i) Wellwood loams and (ii) Wellwood loams, till-substrate phase.

(i) *Wellwood loams* (74,163 acres)

The normal Wellwood loam soils are developed on medium-textured deposits underlain by stratified sand at varying depths below the soil profile. The topography is level, but the soils are dominantly well-drained due to rapid internal percolation. The representative Black soil has the following profile characteristics:

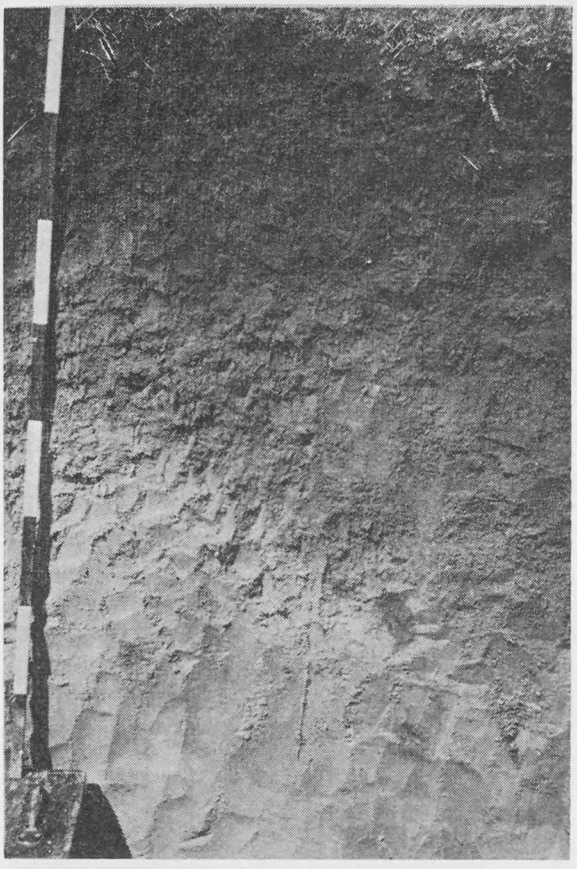


FIGURE 18

Soil profile of the Black member of the Wellwood association. Note stratified sand substrate. (Stick interval—6 inches.)

These soils have a well-developed B horizon which is often finer in texture than the A horizon, yet there is no visible leached A_2 horizon. Where the medium-textured deposits are thin, the B_3 horizon grades into a D horizon which is slightly acid in the upper portion. Where the medium-textured deposits are thick, a loam textured C horizon may occur between the Cca and D horizons.

Associated soils include Black-Meadow, degrading Black-Meadow, Degrading Meadow, and Grey Wooded Gley soils. The Degrading Meadow and Grey Wooded Gley soils occupy the local depressions. The Black-Meadow and degrading Black-Meadow soils occur around the edges of the depressions.

A_{11} –Very dark grey loam (4 to 6 inches thick); granular; friable when moist, slightly hard when dry; neutral to slightly acid.

A_{12} –Dark grey loam (5 to 7 inches thick); granular; friable when moist, slightly hard when dry; neutral to slightly acid in reaction.

B_1 —Greyish brown loam to clay loam (3 to 5 inches thick); fine subangular blocky; friable when moist, slightly hard when dry: slightly acid in reaction.

B_2—Greyish brown clay loam (7 to 11 inches thick); strong, subangular blocky; friable when moist, hard when dry; slightly acid in reaction.

B_3—Light greyish brown to pale brown loam (5 to 10 inches thick); subangular blocky; friable when moist, hard when dry; neutral to slightly alkaline.

Cca–Pale brown loam (6 to 12 inches thick); granular; friable when moist, weakly cemented when dry; mildly alkaline and calcareous. This is a weakly developed calcium carbonate accumulation horizon.

D —Pale brown to light yellow sand; stratified; loose; mildly alkaline and calcareous.

(ii) *Wellwood loams, till-substrate phase* (7,450 acres)

The Wellwood, till-substrate phase soils are developed on medium-textured lacustrine deposits underlain by boulder till at shallow depths. The soils of this phase that occur adjacent to the Newdale soils have irregular topography which conforms with the undulations of the underlying till deposits. In contrast, adjacent to the Arden soils the topography is level as the underlying till deposits are relatively smooth. Internal drainage is impeded by the till substrate and the soils are dominantly moderately well- to imperfectly drained. The representative moderately well-drained Black soil may be described as follows:

A —Very dark grey loam (7 to 12 inches thick); granular; friable when moist, slightly hard when dry; neutral in reaction.

B —Dark greyish brown loam (6 to 12 inches thick); subangular blocky; friable when moist, hard when dry; mildly alkaline in reaction.

Cca–Pale brown loam (8 to 12 inches thick); granular; friable when moist, weakly cemented when dry; moderately alkaline, strongly calcareous.

D —Light grey, clay loam boulder till; pseudofragmental; firm when moist, very hard when dry; moderately alkaline, strongly calcareous; iron stained.

Associated soils include: Black-Meadow, Meadow, Saline Meadow, and Solonetzic Black soils. The Black-Meadow soils occur principally along stream channels. The Meadow and Saline Meadow occur in poorly drained areas with flat topography. Solonetzic Black soils commonly occur adjacent to Meadow soil areas.

Agriculture: The well-drained Wellwood soils are naturally fertile and are suited to all regionally adapted crops. They have thick solums (A and B horizon) which contain a fair to good reserve of organic matter, a favorable reaction, and a fair to good water-retention capacity. In addition they have excellent tilth and good internal drainage and aeration.

Grain production is the dominant farm enterprise although beef cattle are raised on some farms, especially in areas bordering the less-fertile, sandy Stockton soils. The Wellwood loam soils are susceptible to drought in extremely dry seasons due to the low water-retention capacity of the sand substrate. Wind erosion is a problem on fallow as the surface soil pulverizes readily. The degrading soils in the depressions are low in fertility and often are inundated in the spring.

The Wellwood loam, till-substrate phase soils are utilized for grain production, but are better adapted to mixed farming in which case areas with poor drainage, excessive stoniness or salinity can be used for grazing and hay production.

HOLLAND-STOCKTON COMPLEX (6,323 acres)

The Holland-Stockton complex consists of intermixed associates of the Holland and Stockton associations occurring in a complex landscape pattern. The topography of the area is undulating with smooth gentle slopes. The Stockton soils occur on the knolls and ridges, while the Holland soils occupy the lower portion of the slopes and the depressions. The soils which occur in the complex consist of Black and Black-Meadow soils of the Holland association, and Black and Degrading Black soils of the Stockton association. The soils appear to have been developed under grassland vegetation, but the remaining unbroken land now supports a good stand of aspen and oak woods.

Agriculture: The area of Holland-Stockton complex is more suited to mixed farming than it is to grain production. The best utilization of the land on any farm depends on the relative extent and the distribution of the Holland and Stockton soils. As most fields contain areas of Stockton soils which are very susceptible to wind erosion, practices should be adopted to prevent further soil deterioration caused by drifting.

STOCKTON ASSOCIATION (485,632 acres)

The Stockton soils are developed on deep, sandy, deltaic deposits up to 200 feet thick There is a general gradation from west to east in the texture of the deltaic deposits. The sand fraction is dominantly medium sand in the western portion and fine to very fine sand in the eastern portion of the association area. The surface texture varies from sand to very fine sandy loam. A large portion of this soil area is occupied by sand dunes.

The topography is nearly level to very gently undulating, except in the areas of duned sand. Soil drainage is good to excessive over nearly all of the area, due to the high permeability of the sandy material. The native vegetation varies with local environmental conditions. Prairie grasses and some woody shrubs predominate in areas with nearly level topography; aspen and oak groves are intermixed with grassland in the undulating areas; mixed woods occur in areas of duned sand; and aspen and oak woods are dominant adjacent to the Manitoba Escarpment.

The Stockton association has been divided into two textural types and a till-substrate phase of one of these types. These divisions are: (i) Stockton loamy sands, (ii) Stockton fine sandy loams, and (iii) Stockton fine sandy loams, till-substrate phase.

(i) *Stockton loamy sands* (345,933 acres)

The surface texture of the Stockton loamy sands varies from sand to loamy fine sand. This mapping unit includes extensive areas of sand dunes. The topography is very gently undulating, except in the areas of duned sand. The dunes are intermixed longitudinal and crescent shaped and have sharp faces which generally face north and east. Soil drainage is good to excessive. The native vegetation on the very gently undulating topography is intermixed grassland and aspen-oak woods. On the sand dunes, the vegetation varies with position and exposure. The north- and east-facing slopes are favorable regenerative sites for trees and are covered with aspen, bur oak and white spruce. The tops of the dunes are covered by occasional spruce with an undergrowth of ground cedar and mixed prairie grasses. On the south and east slopes, mixed prairie grasses and herbs are the predominant vegetation. An area of moving dunes, devoid of vegetation, occurs in the centre of Township 8, Range 14.

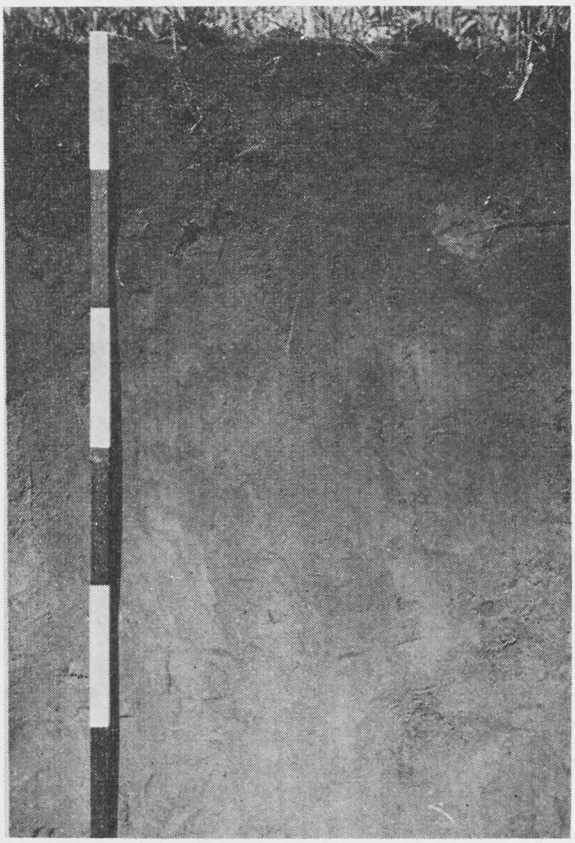


FIGURE 19

Soil profile of the Black member of the Stockton loamy sands. Note the single-grained structure of the soil. (Stick interval—6 inches.)

The representative soil of the Stockton loamy sands is a weakly developed Black and may be described as follows:

A —Very dark greyish brown loamy sand (6 to 12 inches thick); very weakly granular; very friable to loose; neutral in reaction.

AB —Dark greyish brown loamy sand (2 to 4 inches thick); structureless and loose; neutral in reaction.

B —Brown sand (5 to 18 inches thick); structureless and loose; neutral in reaction.

C —Yellowish brown sand; structureless and loose; neutral to slightly alkaline in reaction.

Associated soils include: Degrading Black, Black-Meadow, Meadow and Peaty Meadow soils. The Degrading Black soils occur mainly in the areas near the Manitoba Escarpment. The Black-Meadow soils are small in extent and occur at scattered locations throughout the soil area. The Meadow soils are usually finer in texture than the adjacent well-drained soils. Peaty Meadow soils occur in a few very poorly drained sites.

The regosolic soils which occur on the sand dunes have very feeble profile development consisting mainly of a slight organic matter accumulation in the surface 2 to 6 inches of sandy material. These soils are slightly acid for a depth of 4 feet or more. Many of the dunes contain buried soil profiles at varying depths. These buried profiles represent former surfaces which were subsequently covered by wind-blown sand.

(ii) *Stockton fine sandy loams* (137,190 acres)

The surface texture of the Stockton fine sandy loams varies from loamy sand to very fine sandy loam. The topography is nearly level, and drainage is dominantly good. The native vegetation consists of prairie grasses, such as big and little blue stem and buffalo grass, along with associated herbs and some woody shrubs, mainly snowberry and silverberry. The representative, well-drained soils are Blacks and may be described as follows:

A —Very dark grey fine sandy loam (7 to 15 inches thick); fine granular; very friable when moist, soft when dry; neutral in reaction.

AB –Dark greyish brown fine sandy loam (2 to 4 inches thick); weakly fine granular; very friable when moist, soft when dry; neutral in reaction.

B —Brown loamy fine sand (5 to 10 inches thick); weakly subangular blocky; very friable when moist, slightly hard when dry; neutral in reaction.

B_3—Greyish brown to yellowish brown fine sand (3 to 10 inches thick); structureless and loose; neutral to slightly alkaline in reaction.

Cca–Light greyish brown fine sand; structureless; loose when moist, cemented when dry; slightly alkaline and moderately calcareous. May be a definite horizon of variable depth or may occur as scattered pockets throughout the upper portion of the C horizon.

C —Light yellowish brown fine sand; structureless and loose; slightly alkaline and slightly calcareous.

Associated soils include: Degrading Black, Black-Meadow, and Meadow soils. The Degrading Black soils constitute a large portion of the Stockton fine sandy loams occurring near the Manitoba Escarpment. The Black-Meadow and Meadow soils occur in small scattered areas.

(iii) *Stockton fine sandy loams, till-substrate phase* (2,509 acres)

The Stockton till-substrate phase consists of a small area of Stockton soils in which the sandy deposits are underlain at shallow depths by a calcareous till-substrate. The surface texture varies from loamy fine sand to very fine sandy loam. The topography is smooth and nearly level. Internal drainage is impeded by the till-substrate, so that moderately well- and imperfectly drained soils are dominant. The native vegetation consists of aspen woods and the soils are usually weakly degraded. The representative Degrading Black soil may be described as follows:

O —Very dark brown leaf mat (1 to 3 inches thick); neutral to slightly acid in reaction.

A_1—Very dark greyish brown fine sandy loam (5 to 8 inches thick); weakly fine granular; very friable when moist, soft when dry; slightly acid in reaction.

A_2—Dark greyish brown loamy fine sand (3 to 5 inches thick); weakly fine granular; very friable when moist, soft when dry; slightly acid in reaction.

B —Yellowish brown fine sandy loam (6 to 9 inches thick); weak, fine subangular blocky; friable when moist, slightly hard when dry; slightly acid in reaction.

Cca–Light greyish brown loamy fine sand (6 to 10 inches thick); weakly fine granular; very friable when moist, cemented when dry; mildly alkaline and calcareous; weakly iron stained.

D —Light olive brown, clay loam till; pseudofragmental; moderately alkaline and strongly calcareous; iron stained.

Associated soils include: Black, Black-Meadow, degrading Black-Meadow, and Meadow soils.

Agriculture: The Stockton soils are low in natural fertility and their agricultural value is further limited by their susceptibility to wind erosion. They have a low organic matter reserve which may be rapidly depleted under cultivation through removal of the fine organic particles by wind action. They have a low water-retention capacity and consequently are subject to severe drought. Their agricultural value and adaptability varies with surface texture.

The Stockton loamy sands should not be used for grain production, due to their low fertility and high susceptibility to wind erosion. They can be utilized successfully as grazing land when sown with drought resistant grass species, such as crested wheat grass. The sand dune areas are presently utilized for spring and early summer pasture and for forestry. The livestock-carrying capacity of the duned areas is low, and the native sward is readily thinned by overgrazing. Forestry projects being conducted in the Spruce Woods Forest Reserve have shown that some coniferous trees can be grown on these soils but that growth is slow.

The Stockton fine sandy loams are more suited to cultivation than the Stockton loamy sands, but require careful management. Grain crops can be grown, but special practices are needed to prevent severe loss of soil productivity through wind erosion. Strip cropping, trash cover, wind breaks and crop rotations should all be used for this purpose. A mixed-farming enterprise with emphasis on livestock production is most suitable for these soils.

Crops grown on the Stockton fine sandy loam, till-substrate phase soils are less subject to drought than the same crops grown on the normal Stockton fine sandy loam soils, but these soils are otherwise similar in their agricultural adaptability.

AGASSIZ ASSOCIATION (14,669 acres)

The Agassiz soils are developed on gravel and coarse sandy beach deposits, chiefly of limestone and granitic rock origin. Surface textures vary from sand to fine sandy loam but are characteristically loamy sand. The texture of the soils commonly becomes coarser with depth.

The Agassiz soils occur on beach ridges which generally have a rounded form. The upper portion of the rounded beaches is excessively drained, but along the edges drainage is often imperfect to poor. The native vegetation consists of mixed prairie grasses and associated herbs on the top of the beaches, with some scrubby oak, aspen and willow along the margins.

The representative Agassiz soil is a weakly developed Black and has the following profile characteristics:

A —Very dark grey loamy sand (4 to 8 inches thick); structureless; loose; slightly alkaline in reaction.

B —Greyish brown sand to coarse sand (3 to 7 inches thick); structureless; loose; moderately alkaline in reaction.

Cca–Pale brown coarse sand to gravel (5 to 8 inches thick); structureless; loose; moderately alkaline and calcareous; pebbles are coated with lime carbonate.

C —Stratified coarse sand and gravel.

Black-Meadow soils are associated with the dominant Black soils along the margins of the gravel beaches.

Agriculture: The Agassiz soils have low natural fertility. They are very low in organic matter content and moisture-retention capacity. They may be used as pasture, but their carrying capacity is low. The gravel ridges provide an excellent source of material for road ballast and building purposes.

MARRINGHURST ASSOCIATION (29,286 acres)

The Marringhurst soils are developed on gravel and coarse sandy outwash deposits of shale, limestone and granitic rock origin. The surface texture varies from a loamy coarse sand to sandy loam but the coarse textures predominate. The texture of the soil commonly becomes coarser with depth.

The topography is level to gently undulating. The soils are dominantly well-drained due to rapid percolation. However, along the bottom of abandoned river channels poor drainage is general due to seepage from adjacent gravel deposits and impeded internal drainage in the channels. The native vegetation is mixed prairie grasses and associated herbs on well-drained sites and meadow grasses associated with willow and aspen on the poorly drained sites.

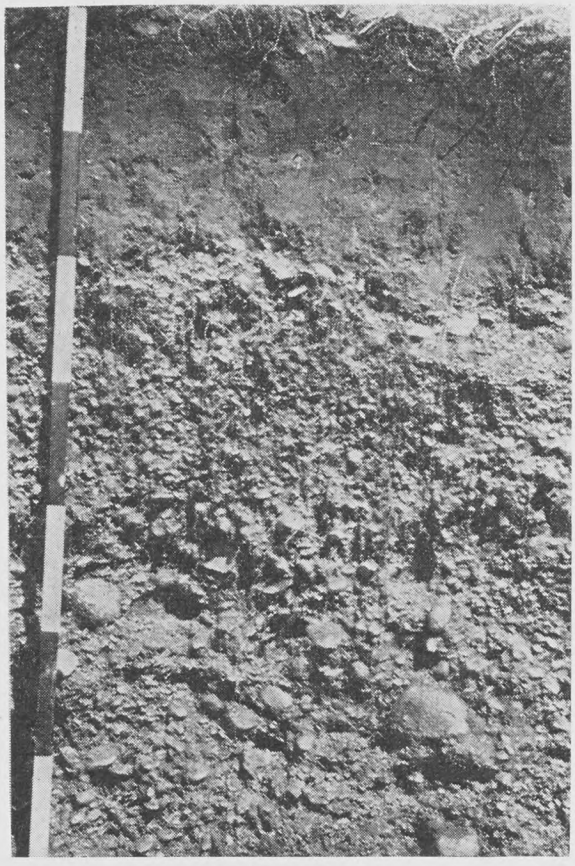


FIGURE 20
Soil profile of Black member of the Marringhurst association. (Stick interval—6 inches.)

The well-drained Marringhurst soils are weakly developed Black soils which may be described as follows:

A —Very dark grey loamy sand to coarse sand (3 to 7 inches thick); weakly granular to structureless; very friable to loose; neutral to mildly alkaline.

AB –Very dark greyish brown loamy sand to coarse sand (1 to 3 inches thick); weakly granular to structureless; very friable to loose; neutral to mildly alkaline.

B —Brown loamy sand to coarse sand (3 to 5 inches thick); weakly subangular blocky or structureless; very friable to loose, slightly cemented when dry; mildly alkaline.

Cca–Light yellowish brown coarse sand and gravel (5 to 12 inches thick); structureless; loose, weakly cemented when dry; moderately alkaline and calcareous.

C —Yellowish brown, stratified coarse sand and gravel; structureless; loose; alkaline in reaction.

Associated Meadow and Peaty Meadow soils occur in abandoned river channels.

Agriculture: The Marringhurst soils are low in natural fertility and have very low moisture-retention capacity. Small areas are cultivated but productivity is low. Wind erosion has been severe on cultivated soils, especially in dry years. These soils are best utilized for permanent pasture.

MINIOTA ASSOCIATION (91,367 acres)

The Miniota soils are developed on sandy and coarse sandy outwash deposits. These deposits usually become coarser with depth and a gravel substrate is of common occurrence. The surface texture varies from sand to fine sandy loam. A small acreage of dune sands occur within the Miniota soil area.

The topography of the Miniota soils is level to slightly undulating, except in local areas where the sands have been duned. Soil drainage is good to excessive as internal drainage is very rapid. The native vegetation is largely mixed prairie grasses and associated herbs. Aspen occurs in local imperfectly drained sites, and ground cedar is common on the coarser-textured, well-drained soils.

The Miniota association has been divided into two textural types. These types are (i) Miniota sands and (ii) Miniota sandy loams.

(i) *Miniota sands* (75,520 acres)

The Miniota sands vary from sand to loamy sand in surface texture. The representative well-drained soil is a regosolic Black and has the following characteristics:

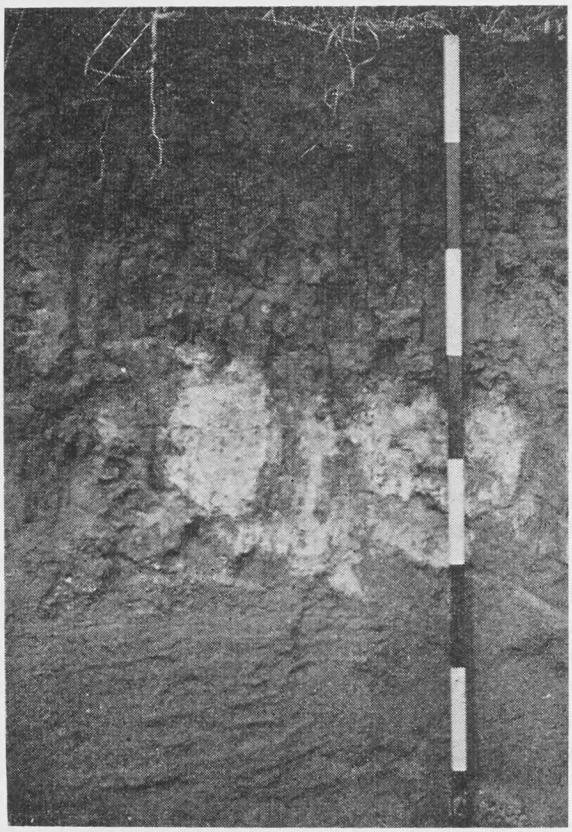


FIGURE 21
Soil profile of the Black member of the Miniota sandy loams. (Stick interval—6 inches.)

A —Dark grey loamy sand (4 to 12 inches thick); structureless; loose; slightly acid in reaction.

B —Grey brown grading to light yellowish brown coarse sand (6 to 15 inches thick); structureless; loose, slightly acid in reaction.

C —Very pale brown coarse sand and gravel; stratified; loose, mildly alkaline in reaction.

Associated soils include Degrading Black and Meadow soils. The Degrading Black soils are slightly acid throughout the profile. Meadow soils occur in abandoned water channels.

(ii) *Miniota sandy loams* (15,847 acres)

The surface texture of the Miniota sandy loams varies from loamy sand to fine sandy loam but sandy loam textures predominate. The dominant soil is a Black and may be described as follows:

A —Very dark grey sandy loam (7 to 13 inches thick); granular; very friable when moist, slightly hard when dry; neutral in reaction. Grades into:

B —Brown loamy sand (8 to 14 inches thick); weakly prismatic, weakly subangular blocky; very friable when moist, slightly hard when dry; slightly acid to neutral in reaction.

Cca–Very pale brown loamy sand (4 to 6 inches thick); finely granular; very friable to loose, cemented when dry; strongly calcareous and moderately alkaline.

D —Pale brown coarse sand and gravel; stratified; loose; slightly calcareous and slightly alkaline.

Associated Meadow soils occur in abandoned river channels. Small areas of Black-Meadow soils occur at scattered locations.

Agriculture: The fertility and agricultural adaptability of the Miniota soils varies with surface texture. The sand and loamy sand soils have limited natural fertility and are subject to severe wind erosion when cultivated. The sandy loam soils have a fair supply of organic matter, but are only fair to poor for cereal crops as they have a low moisture-retention capacity.

The Miniota sand soils are best utilized as pasture land, although livestock-carrying capacity is low. The Miniota sandy loam soils may be used for limited grain production but grasses and legumes should predominate in the rotation and trash cover and trees must be utilized as soil erosion control measures.

SOIL ASSOCIATIONS IN WHICH THE DOMINANT SOIL IS A BLACK-MEADOW OR CALCAREOUS MEADOW

ARDEN ASSOCIATION (742 acres)

The Arden loam to clay loam soils are developed on medium-textured, reworked boulder till of limestone and granitic rock origin. A thin lacustrine mantle occurs in local sites. Surface stones are numerous throughout the association.

The topography is nearly level. Drainage is imperfect to poor, as surface runoff and internal drainage are slow. The native vegetation is meadow-prairie and meadow grass associations intermixed with aspen and balsam poplar groves. Some bur oak occurs on better drained sites.

The dominant calcareous Black-Meadow soil may be described as follows:

O —Very dark brown leaf and sod mat (1 to 2 inches thick); slightly alkaline in reaction.

A —Very dark grey clay loam (5 to 12 inches thick); finely granular; very friable when moist, hard when dry, moderately alkaline and calcareous.

Cca–Light grey brown, clay loam boulder till (5 to 10 inches thick); finely granular: very friable when moist, cemented when dry; strongly calcareous and moderately alkaline; weakly iron stained.

C —Pale brown clay loam boulder till; pseudo-granular; friable, sticky when wet: moderately alkaline and strongly calcareous; iron stained.

Associated soils include Black, Meadow, Calcareous Meadow and Saline Meadow soils. The Black soils occur in local well-drained sites. The Meadow and Saline Meadow soils cover large areas and are widely distributed throughout the extent of the association.

Agriculture: The Arden soils have fair to good natural fertility. They have a good moisture-retention capacity and a fair reserve of organic matter. Salinity and poor drainage adversely affect soil productivity in some areas.

The soils are utilized mainly for grain production. Stoniness interferes with, and in some areas inhibits, cultivation. In periods of heavy rainfall, local surface runoff accumulates in the enclosed depressions. The calcium carbonate in the surface horizon decreases the availability of some essential plant nutrients. This may be offset by the application of fertilizers.

WESTBOURNE ASSOCIATION (48,742 acres)

The Westbourne clay soils are developed on a thin, clay-textured lacustrine deposit overlying fine-textured boulder till. The lacustrine mantle ranges up to two feet in depth and is thickest in the depressional areas. The surface clay deposit is nearly stone-free, but the underlying clay-textured till contains many pebbles, cobbles and larger stones. A substrate of highly calcareous, clay loam-textured boulder till usually occurs at depths of four to six feet and is closer to the surface in areas adjacent to the Isafold association.

The topography is level to depressional. Surface runoff is slow to very slow and internal drainage is very slow. Consequently, the soils are imperfectly, poorly, and very poorly

drained. The native vegetation consists of meadow grasses and herbs intermixed with clumps of willow and some aspen in the imperfectly and poorly drained sites, and sedges in the very poorly drained sites. Salt-tolerant plants such as glasswort, seablite, salt grass, wild barley and gumweed are common in local sites throughout the soil area.

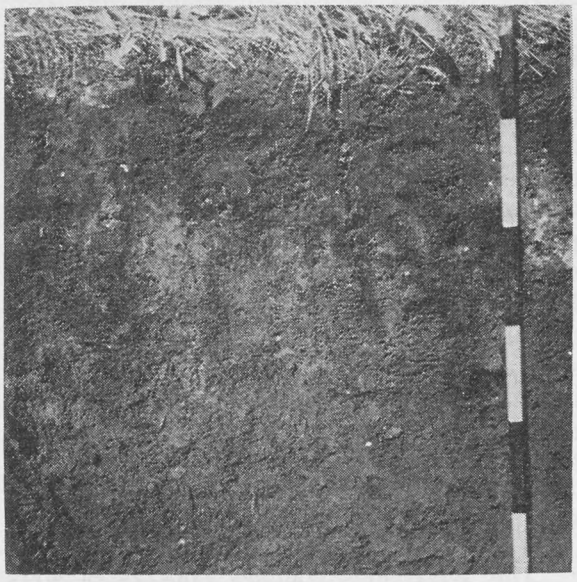


FIGURE 22

Soil profile of the Calcareous Meadow member of the Westbourne association. (Stick interval—6 inches.)

The dominant soil of the Westbourne association is a Calcareous Meadow soil which is usually slightly saline. A generalized profile description of this soil is given below:

O —Very dark grey muck (3 to 5 inches thick); slightly alkaline and calcareous.

Ag—Very dark grey clay (4 to 10 inches thick); fine granular; very sticky and plastic when wet, very hard when dry; low porosity; moderately alkaline and calcareous; moderately gleyed.

Cca–Light grey clay to silty clay (6 to 12 inches thick); fine granular; very sticky and plastic when wet, cemented when dry; moderately alkaline and strongly calcareous: iron stained; often contains gypsum crystals.

C —Light olive grey clay; pseudo-fine granular; very sticky and plastic when wet, hard when dry; low porosity; moderately alkaline and moderately calcareous; iron stained; usually contains salt crystals.

Associated soils include: Peaty Meadow, Saline Meadow, Solonchak, and Black Solonetz soils. The Peaty Meadow soils occur in very poorly drained depressions. Most of the peat was burned off these soils prior to cultivation. The Saline Meadow and Solonchak soils occur in local sites throughout the soil area and are especially prevalent near the Whitemud River. Solonetzic soils occur mainly in areas where the soil drainage has been improved.

Agriculture: The Westbourne soils are fair to poor in natural fertility. Their productivity is impaired by poor drainage and aeration, high calcium carbonate content, and the presence of soluble salts in toxic quantities. Tillage operations are hampered by poor soil tilth, frequent excessively wet conditions, and local stoniness. These soils are best suited for hay production and pasture. Fair yields of barley, flax and forage crops can be obtained on areas with improved drainage. Legumes may be grown in areas which are not subject to flooding during the spring or after heavy summer rains. The occurrence of "bare spots" in pastures and grain fields, caused by high concentrations of toxic salts, can be expected, especially in the northern portion of the soil area.

MARQUETTE ASSOCIATION (11,520 acres)

The Marquette clay soils are developed on thin, fine-textured lacustrine deposits underlain by medium-textured boulder till at 16 to 30 inches below the surface. Stoniness is not a

problem over most of the soil area as the lacustrine sediments over the till cover all but a few of the larger stones and boulders.

The topography is nearly level with some shallow depressional areas. Surface runoff is slow and often accumulates in the large undrained depressions. As internal drainage is also slow, the soils are dominantly imperfectly to poorly drained. The native vegetation consists of: tall prairie grasses and herbs with some aspen on the better-drained sites; sedges, meadow grasses and willow on the poorly drained sites and patches of salt-tolerant plants on localized saline areas.

The dominant Black-Meadow soil may be described as follows:

A —Dark grey clay (6 to 10 inches thick); granular; very plastic and sticky when wet, very hard when dry; neutral to slightly alkaline in reaction.

B —Brownish grey clay (4 to 8 inches thick); granular; very sticky and plastic when wet, very hard when dry; slightly alkaline in reaction.

Cca–White to pale brown heavy clay loam to clay (6 to 12 inches thick); fine granular; plastic and very sticky when wet, cemented when dry; moderately alkaline and strongly calcareous; contains some stones.

C —Light brownish grey heavy clay loam; pseudo-fine granular; plastic and very sticky when wet, hard when dry; moderately alkaline and calcareous; iron stained; may contain gypsum crystals. This horizon may be absent or up to 10 inches thick. There is often a thin gravelly or cobbly lense at the junction of the C and D horizons.

D —Light grey, clay loam till or reworked till; calcareous; iron stained and may contain gypsum crystals.

Associated soils include: Black, Calcareous Meadow, Peaty Meadow, Saline Meadow, Solonchak, and Black Solonetz soils. The Black soils are limited in extent. Large areas of Meadow soils occur in the broad, shallow depressions. Solonchak and Solonetzic soils occur in local areas. Generally the clay-textured lacustrine mantle is thicker than normal in the poorly drained Meadow soils and thinner than normal in the well-drained Black soils.

Agriculture: The better-drained Marquette soils are moderately fertile. They have a high moisture-retention capacity and a good reserve of organic matter. The fertility of the Meadow soils is lower due to poor drainage and aeration, salinity, and the presence of calcium carbonate in the surface horizons.

The Marquette soils are utilized largely for grain production. Good soil management is necessary to maintain and improve soil productivity. Surface drainage is needed in some areas to prevent local flooding and to aid in the reduction of soil salinity. Adapted salt- and water-tolerant crops should be grown on poorly drained soils. Some of the saline soils are suitable only for pasture. When Peaty Meadow soils are brought under cultivation the organic layer should be mixed with the mineral soil to improve tilth and soil porosity. The inclusion of grasses and legumes in the crop rotation helps to improve the tilth and productivity of these clay-textured soils.

WOODLANDS COMPLEX (12,467 acres)

The Woodlands complex consists of soils that have been developed on shallow, medium-textured lacustrine deposits which lie over medium-textured, highly calcareous till. The lacustrine deposits range from a few to thirty inches in thickness. Surface textures vary from fine sandy loam to silty clay loam. Surface stones are sufficient to hinder cultivation where the lacustrine mantle is thin, but few stones occur in areas where the lacustrine mantle is thick.

The topography is level to very gently sloping. Soil drainage is imperfect to poor as surface runoff is slow and internal drainage is impeded by the boulder till-substrate. The native vegetation is largely meadow prairie and meadow grasses and herbs. Aspen, willow and occasional oak occur on the better-drained sites.

The dominant soil is a calcareous Black-Meadow intergrade. These soils have a dark grey "A" horizon, 6 to 10 inches in depth,

which is fine sandy loam to silty clay loam in texture, friable, and moderately calcareous. This horizon tongues into a white, calcium carbonate accumulation horizon. In some soils mottling occurs within the "A" horizon. This is most common in profiles containing a gravelly erosion surface between the lacustrine sediments and the boulder till. This erosion surface characteristically is a thin layer of sand, gravel and cobbles, but may be up to two or more feet thick in local areas. The underlying till substrate is clay loam in texture, strongly calcareous, and iron stained.

Associated soils include Calcareous Meadow, Saline Meadow and Solonchak soils. The surface texture of the poorly drained soils in depressions is usually finer than the texture of the soils in better-drained sites.

Agriculture: The natural fertility of the Woodlands soils is impaired by poor soil drainage, and by the free calcium carbonate in the surface horizons which reduces the availability of plant nutrients. The soils have good water-retention capacity and a fair reserve of organic matter.

Fair to good crops of grain are produced on these soils. Legume and grass crops should be grown in rotation to maintain the organic matter content of the soil. Phosphate fertiliziers are almost essential since the soil phosphate is largely non-available to plants. Stony and saline areas are best adapted to hay production and pasture. The adoption of recommended management practices is contingent upon the presence of adequate drainage facilities to remove excess surface water.

RED RIVER ASSOCIATION (166,554 acres)

The soils of the Red River association have been developed on lacustrine clay sediments in the central basin of glacial Lake Agassiz. The surface texture is uniformly clay. Stones are absent except in local areas where the clay covering over the till is comparatively thin.

The topography is nearly level. Portions of the clay plain have broad, very gently sloping, low ridges which trend in a northwesterly and southeasterly direction. Other portions are depressional. There is a fall in elevation of about two feet per mile from the western edge of the clay plain to the Red River channel in the axial portion of the basin. Soil drainage is imperfect to poor as surface runoff and internal drainage are slow. Drainage has been improved over most of the association area by artificial surface drains. The native vegetation is prairie, meadow prairie and meadow grass associations which occur in conformity with the various degrees of natural drainage. Trees grow naturally as a fringe of woods along the stream channels. Since settlement, agricultural crops have replaced the native vegetation with the exception of the meadow grasses in some poorly drained areas and the wooded fringe along the intermittent water courses and stream channels.

The Red River association consists of a number of associates or series which are distinctly different in physical features and agricultural characteristics. As it was not possible to show the location and extent of each of these soils on the reconnaissance soil survey map, they were grouped into two divisions based on soil drainage. These divisions are: (i) Red River clay in which the soils are moderately well to imperfectly drained and (ii) Osborne clay in which the soils are poorly drained. The occurrence of solonetzic and saline soils within areas designated as Red River or Osborne clay is shown by the use of symbols.

(i) *Red River Clay* (125,722 acres)

The Red River clay soils occur on the broad, low ridges and along stream channels. A generalized description of the representative solonetzic Black-Meadow soil is given on page 58.

Associated soils include Black and Black Solonetz soils. The Black soils constitute only a small portion of the total area. The distribution of Black Solonetz soils, which constitute a considerable portion of the area, is

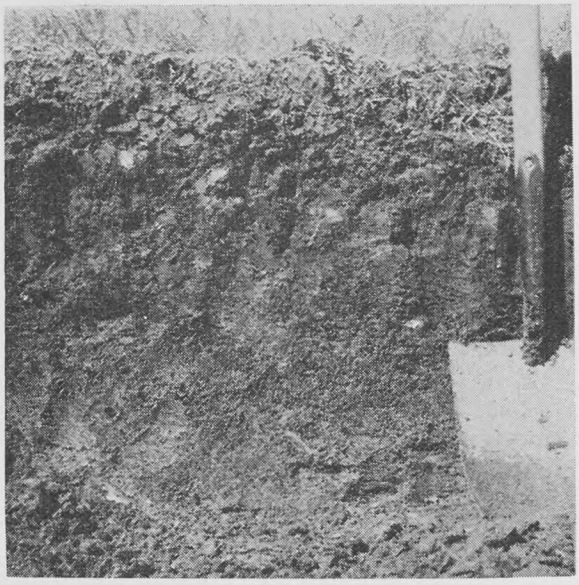


FIGURE 23
Soil profile of the Red River clay which is a solonetzic Black-Meadow.

shown by symbols on the map. Various degrees of solonization occur but these intergrades cannot be separated in reconnaissance mapping.

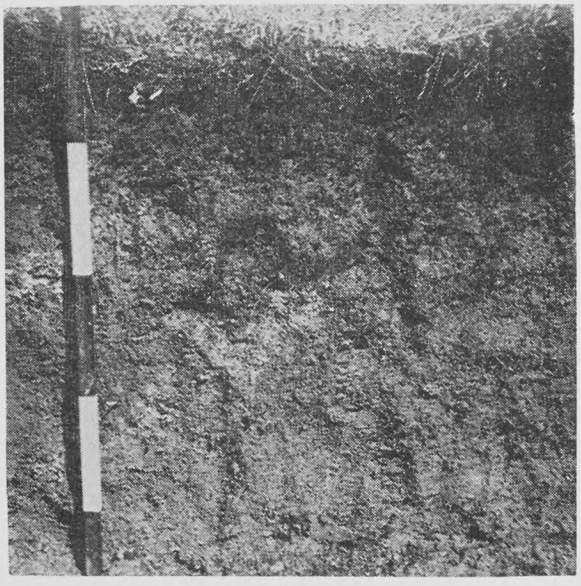


FIGURE 24
Soil profile of the Osborne clay which is a Meadow.

A —Dark grey clay (7 to 10 inches thick); granular; very hard when dry; very plastic and sticky when wet; neutral in reaction.

B —Dark greyish brown clay (4 to 6 inches thick); prismatic structures break to medium granular aggregates; very hard when dry, very plastic and very sticky when wet; slightly alkaline. Blends gradually into:

C —Olive grey clay; amorphous; very hard when dry, very plastic and sticky when wet and moist; slightly alkaline and weakly calcareous, iron stained; gypsum crystals may be present.

(ii) *Osborne Clay* (40,832 acres)

The Osborne soils occupy the shallow depressional areas of the clay plain. A description of the dominant Meadow soil is given below:

A —Dark grey clay (3 to 6 inches thick); usually high in organic matter content; coarse granular; very plastic and very sticky when wet, very hard when dry; neutral in reaction.

Cg—Olive grey clay (6 to 10 inches thick); fine granular aggregates; very sticky and very plastic when wet; slightly alkaline; iron stained.

C —Light olive grey clay; amorphous; very dense, very sticky and very plastic when wet; iron stained and contains lime carbonate concretions.

Associated soils include Saline Meadow, Solonetzic Meadow, Calcareous Meadow and Peaty Meadow soils. The location of Saline Meadow and Solonetzic Meadow soils is indicated on the soil map by the use of symbols. Most of the peat has been removed either by cultivation or fire, but scattered areas of Peaty Meadow soils still occur.

Agriculture: The Red River clay and Osborne clay soils vary in their adaptability to agriculture. The Red River clay soils have a favorable reaction, relatively good reserve of organic matter and excellent water-retention capacity. Drainage is imperfect and the soils are difficult to till because of their fine texture. The Osborne clay soils have favorable reaction and excellent water-retention capacity. However, drainage is very slow and the soils may be periodically flooded. In addition, the organic matter reserve is low, the soils usually contain toxic salts, and tillage is often difficult.

The Red River clay soils are utilized predominantly for grain production as they are very suited to mechanized farming. They can also be utilized for row crops, grasses and legumes. Harvesting is often delayed in wet falls as drainage is slow. These soils are not well suited to root crops, as the shape of the roots is distorted due to restriction of growth and the removal of earth from the roots at harvest is difficult.

The Osborne clay soils are utilized almost entirely for grain and grass hay production. Row and legume crops can be grown but surface flooding is often a problem. An adequate soil drainage system is required and periodic attention is needed to maintain its efficiency.

Successful cultivation of the Red River clay and Osborne clay soils depends on the maintenance of an adequate level of organic matter which is essential to good tilth and soil fertility. The grain-fallow type of rotation generally followed on these soils gradually depletes the reserve of organic matter. Farm practices which offset this loss of organic matter include the use of grass and legume crops in the rotation and the return of all crop residues to the soil.

BURNSIDE ASSOCIATION (23,142 acres)

The Burnside soils are developed on silty-textured deltaic sediments. The predominant surface texture is silty clay but loam- to clay-textured soils are encountered. The coarser-textured soils occur adjacent to the Almasippi soils and the finer-textured soils occur adjacent to the Red River soils. A few stones are encountered on the surface and in the soil profile.

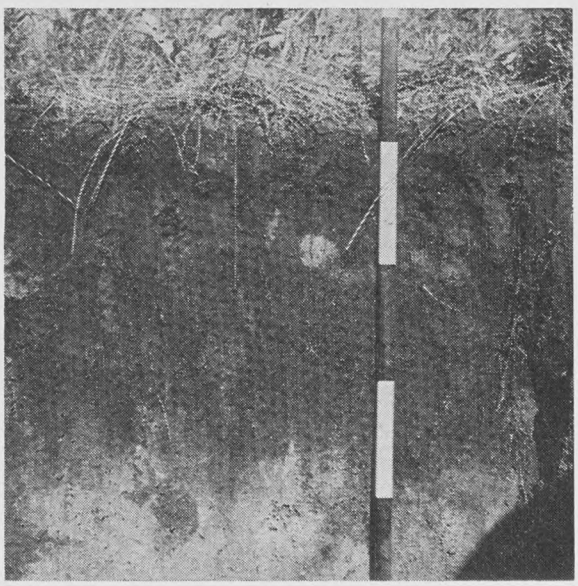
The topography is very gently sloping in the vicinity of the Burnside Beach, but in other areas it is level to depressional. Soil drainage is imperfect to poor as surface runoff is slow and internal drainage is impeded by a fine-textured substrate. The native vegetation consists of tall prairie grasses, meadow-prairie grasses and meadow grasses which occur in conformity with the various degrees of natural drainage. Trees grow naturally along stream channels. The native vegetation has been almost completely removed and the Burnside soils are almost completely utilized for agricultural crop production.

Black-Meadow soils constitute by far the largest acreage in the Burnside association. A representative profile is described on page 60, (see Figure 25).

Associated soils include: Black, Meadow, Calcareous Meadow and Saline Meadow soils. The Black soils are limited to a narrow strip adjacent to the Burnside Beach. The Meadow soils constitute a very small percentage of the Burnside association. The local salinity which occurs in the Burnside soils is seldom strong enough to be harmful to cereal crops.

Agriculture: The Burnside soils are very productive. They have a good supply of organic matter, a favorable soil reaction and good moisture-retention capacity. However, soil drainage is imperfect and the soils tend to become water-logged in wet seasons.

At present the Burnside soils are utilized almost entirely for grain production, although



A —Very dark grey silty clay (8 to 12 inches thick); fine granular; plastic and sticky when wet, moderately friable when moist; slightly alkaline in reaction.

B —Dark grey silty clay (3 to 8 inches thick); coarse granular; plastic and sticky when wet, firm when moist; moderately alkaline in reaction. Grades sharply into:

Cca–Light brownish grey silty clay (8 to 12 inches thick); fine granular; plastic and sticky when wet, moderately friable when moist; calcareous and weakly iron stained. Blends gradually into:

C —Pale brown silty clay; pseudo-fine granular; plastic and sticky when wet, hard when dry; moderately alkaline and calcareous; iron stained and contains gypsum crystals. An occasional pebble or cobble is present.

FIGURE 25

Soil profile of the Black-Meadow member of the Burnside association. (Stick interval—6 inches.)

they also are suited to row crops, roots, peas and forage crops. The Burnside soils are gradually becoming more susceptible to wind erosion as the grain-fallow type of rotation being practiced causes gradual deterioration of soil structure. Grasses and legumes are required in the crop rotation to prevent this deterioration of soil structure and consequent loss of fertility through wind erosion.

LAKELAND ASSOCIATION (5,043 acres)

The Lakeland soils are developed on strongly-calcareous, silty-textured deltaic deposits. The deltaic deposits are generally more than 30 inches thick and are underlain by highly calcareous boulder till. The surface texture of the Lakeland soils varies from fine sandy loam to silty clay, but silty clay loam predominates.

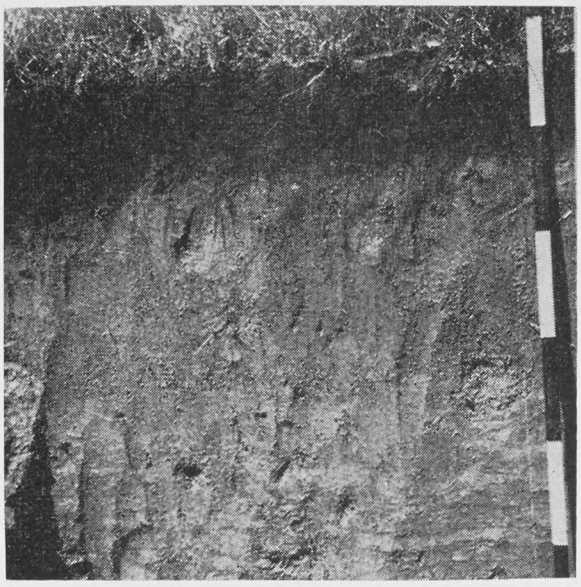
The topography of the Lakeland association is smooth to very gently sloping. In some areas the soils occupy a depressional position. Surface run-off is slow and internal drainage is impeded by the boulder till substrate. Consequently the Lakeland soils are imperfectly to poorly drained. The natural vegetative cover of the Lakeland soils is meadow-prairie and meadow grasses interspersed with willow and scrubby aspen. At present the Lakeland soils are almost entirely cultivated and the native vegetation has been replaced by agricultural crops, except on road allowances and in some poorly drained sites.

The dominant soil of the Lakeland association is a calcareous Black-Meadow soil and is described on page 61, (see Figure 26).

Associated soils include: Calcareous Meadow and Peaty Meadow soils. In the poorly drained depressions a thin layer of clay often occurs between the calcareous till substrate and the deltaic sediments on which the Lakeland soils are developed. Some of the Meadow soils are weakly salinized.

Agriculture: The Lakeland soils have a good moisture-retention capacity and a moderately good reserve of organic matter, but their productivity is impaired by an excessively high content of calcium carbonate and by imperfect to poor drainage.

These soils are being utilized mainly for grain production, but are better suited to



A —Dark grey silty clay loam (5 to 12 inches thick); fine granular; friable when moist, slightly hard when dry; moderately calcareous. Tongues of the "A" horizon may extend to 16 or more inches below the surface.

Cca–Light grey to white silty clay loam (6 to 10 inches thick); fine granular; friable when moist, cemented when dry; slightly iron stained and very high in calcium carbonate content. Blends gradually with:

C —Very pale brown silty clay loam; moderately friable when moist, hard when dry; iron stained and strongly calcareous, some gypsum may be present.

D —Pale brown, clay loam boulder till; very calcareous. Occurs at a depth of 30 inches or more.

FIGURE 26

Soil profile of the calcareous Black-Meadow member of the Lakeland association. (Stick interval—6 inches.)

mixed farming. They are susceptible to wind erosion when not protected by a growing crop or trash cover. They are low in available phosphorous and nitrogen and will respond to applications of fertilizers containing these nutrients. The poorly drained soils are best suited to hay production or for pasture usage, but can be cultivated if adequate drainage is installed and maintained. Cattle raised on feed grown on these soils often show symptoms of phosphate deficiency and must be fed supplements.

ALMASIPPI ASSOCIATION (534,297 acres)

The Almasippi soils are developed on the sandy deltaic deposits of the Lower Assiniboine Delta. These sandy sediments are underlain by a finer-textured substrate usually at about ten feet below the surface. The surface texture of the Almasippi soils ranges from sand to very fine sandy loam.

The topography is level, except in areas which have been blown into sand dunes. The Almasippi soils have developed under varying degrees of imperfect drainage, as surface runoff is slow and internal drainage is impeded by the finer textured substrate. The native vegetation consists of tall prairie grasses, meadow grasses and sedges interspersed by areas of aspen poplar, balsam poplar, willow and associated shrubs. Aspen poplar is the predominant vegetation in the areas of sand dunes and on the coarser-textured soils that have not been brought under cultivation.

The Almasippi association has been divided into two textural types and a clay-substrate phase. These divisions are (i) the Almasippi sand, (ii) the Almasippi loamy sands and (iii) the Almasippi, clay-substrate phase.

(i) *Almasippi sands* (216,934 acres)

The surface texture of the Almasippi sands varies from loamy fine sand to sand. The topography is level, except in areas where the sands have been duned. Soil drainage is imperfect to poor, although better drainage is encountered in duned sections where the sand deposits are relatively thick.

The dominant soil in this textural type is a degrading Black-Meadow soil which has the following profile features:

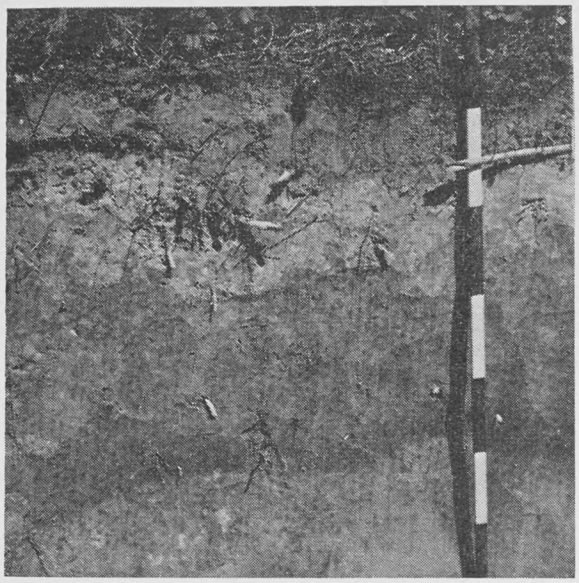


FIGURE 27

Soil profile of the degrading Black-Meadow member of the Almasippi association sand textural type. (Stick interval —6 inches.)

A —Very dark brown leaf and sod mat about 2 inches thick; neutral in reaction.

A_1—Very dark grey loamy fine sand (1 to 2 inches thick); weakly fine granular, very friable when moist, soft when dry; neutral in reaction.

A_2—Dark grey fine sand (3 to 9 inches thick); structureless; loose, neutral to slightly acid; may be slightly iron stained. Grades gradually into:

B —Greyish brown loamy fine sand (10 to 16 inches thick); structureless to weakly developed fine granular structure; very friable to loose; neutral to slightly alkaline; contains some iron concretions. Fades into:

C_1—Pale brown fine sand (8 to 15 inches thick); structureless; loose, alkaline but seldom calcareous; iron stained.

C_2—Very pale brown to yellow fine sand; structureless; loose; moderately calcareous and iron stained.

Associated types include: Meadow, Peaty Meadow and Degrading Black soils. The Meadow soils generally are slightly alkaline in the "A" horizon although local depressional areas are calcareous at the surface. The Degrading Black soils are moderately well-drained and have deeply leached profiles with weak horizon differentiation, very low organic matter and slightly acid reaction. Free lime carbonate in these soils is seldom encountered within five feet of the surface.

(ii) *Almasippi loamy sands* (304,563 acres)

The Almasippi loamy sands vary in texture from loamy sand to very fine sandy loam. The topography is level to depressional over most of this textural type. Soil drainage is imperfect to poor. A generalized description of the dominant Black-Meadow soil is given on page 63, (see Figure 28).

Associated types include: Degrading Black-Meadow, Meadow, Peaty Meadow, Calcareous Meadow and Saline Meadow soils. The degrading Black-Meadow soils occur on the broad low ridges which are generally coarser in texture and somewhat better drained. The poorly drained soils occur in broad depressions. In most cases the surface texture of the poorly drained soils is finer than that of the Black-Meadow soils and bands of finer textured materials may be found at various depths in the soil profile. The Meadow and Calcareous Meadow soils are dominant, whereas the Peaty Meadow and Saline Meadow soils constitute a minor percentage of the total area. In some sites the peat has been largely removed from the Peaty Meadow soil areas by fire or cultivation.

(iii) *Almasippi clay-substrate phase* (12,800 acres)

The soils of the Almasippi, clay-substrate phase are developed on sandy textured surface material which lies over a clay substrate at 10 to 30 inches below the surface. Surface texture is usually very fine sandy loam, although finer textures occur adjacent to the Red River and Oakville associations. Surface runoff is very slow as the topography is level to depressional and internal drainage is impeded by the clay

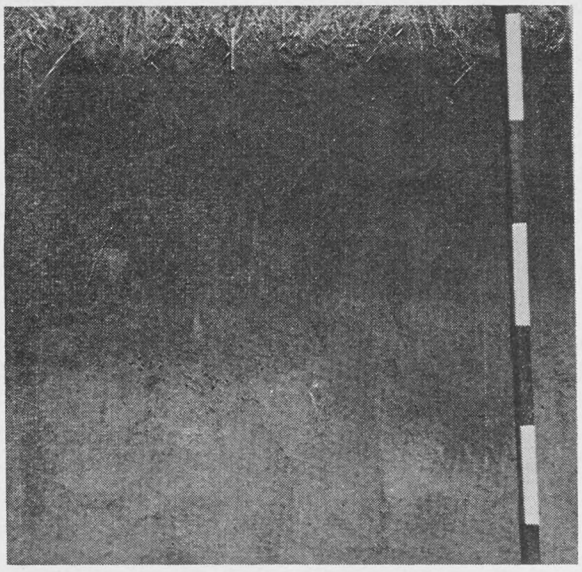


FIGURE 28

Soil profile of the Black-Meadow member of the Almasippi association, loamy sand textural type. (Stick interval—6 inches.)

substrate. Consequently, soil drainage is poor to imperfect.

The dominant associate is a Black-Meadow soil which may be described as follows:

A —Very dark grey very fine sandy loam (8 to 12 inches thick); fine granular; friable; slightly alkaline in reaction.

Cca–Very pale brown very fine sandy loam of variable thickness; fine granular; friable; strongly calcareous; weakly iron stained.

C —Very pale brown fine sand. "C" horizon may be present or absent depending on the depth at which the clay substrate occurs.

D —Moderately calcareous clay.

Associated soils include: degrading Black-Meadow, Meadow, Peaty Meadow, Calcareous Meadow and Saline Meadow soils.

Agriculture. The agricultural value of the Almasippi soils varies with texture and soil drainage. Generally the soils have a relatively low natural fertility as they have low moisture-retention capacity and a limited reserve of organic matter. In addition, they are very susceptible to wind erosion.

A —Dark grey loamy fine sand (6 to 12 inches thick); weakly fine granular; very friable; slightly alkaline in reaction. Blends gradually into:

B —Dark greyish brown loamy fine sand to fine sand (5 to 10 inches thick); structureless; loose to slightly cemented when dry; moderately alkaline in reaction. Grades sharply into:

Cca–Very pale brown fine sand (12 to 16 inches thick); structureless; slightly cemented when dry; strongly calcareous; iron stained. Blends gradually with:

C —Very pale brown fine sand; structureless; loose; calcareous and iron stained. May contain some gypsum.

The Almasippi sand soils on level topography are suited to stock raising and the production of forage and hay crops, whereas the occluded sand dune areas are suitable only to limited pasturage. Cereal crops, especially oats, may be grown in the crop rotation about two years out of five, but the yield of grain will usually be small. On cultivated soils the use of trash cover and native or planted field shelterbelts is essential for protection against wind erosion.

The Almasippi loamy sands are suited to mixed farming with major emphasis on livestock. Crop rotations should be adopted which include one to two years of grasses and legumes in a four or five year rotation. In addition, field shelterbelts, trash cover and suitable tillage practices are needed to reduce the susceptibility of the soil to wind erosion. Poorly drained soils are suited to hay and pasture, although cereal crops may be grown in dry years and where adequate drainage can be provided. The agricultural management of the severely eroded fields should be very similar to that suggested for the Almasippi sands.

The Almasippi clay substrate phase soils are suited to mixed farming. However, they are susceptible to wind erosion and crop rotations should be adopted which minimize this hazard. Another serious problem is the high water table which contributes to considerable flooding of the soils in wet seasons. This problem can be largely overcome by surface drainage in much of this soil area. Poorly drained soils are suitable to hay production and pasture, although they may be cultivated under improved drainage conditions.

SOURIS ASSOCIATION (9,753 acres)

The Souris association of soils is developed on sandy-textured, deltaic deposits in the Brandon Lakes Plain. The sandy sediments are underlain by finer-textured deposits at varying depths below the profile. The Souris soils in the Carberry Map Sheet area vary in texture from loamy fine sand to fine sandy loam.

The topography of the Souris soils is smooth to very gently sloping. Internal drainage is impeded by the finer-textured substrate and consequently the soils are generally imperfectly drained. The native vegetation is predominantly mixed prairie grasses.

The dominant soil is a Black-Meadow which has the following profile feature:

A —Dark grey fine sandy loam (8 to 10 inches thick), weakly fine granular, very friable; slightly alkaline in reaction.

AC —Greyish brown loamy fine sand (4 to 8 inches thick), weakly fine granular; extremely friable; alkaline in reaction, contains free calcium carbonate.

C —Light yellowish brown fine sand; structureless; loose; alkaline, strongly calcareous; weakly iron stained.

Associated soils include: Black, Meadow and Calcareous Meadow soils.

Agriculture: The Souris soils have moderate to low natural fertility. They have limited water-retention capacity and a moderate supply of organic matter.

The soils on the Carberry Map sheet are utilized almost entirely for grain. Fair yields are obtained but serious wind erosion has occurred under the continued use of the grain-fallow crop sequence. Wind erosion on the Souris soils can be controlled by a combination of cultural practices. These include: the inclusion of grasses and legumes in the rotation, the preservation of trash cover during the fallow year, the use of fall-seeded cereals to control winter and spring wind erosion, and the use of field shelterbelts to protect the soil from strong winds.

SOIL ASSOCIATIONS IN WHICH THE DOMINANT SOIL IS A DEGRADING BLACK

FIRDALE ASSOCIATION (64,716 acres)

The Firdale soils are developed on sandy-to medium-textured lacustrine deposits which occur in a narrow belt along the top of the Manitoba Escarpment. The surface texture ranges from loamy fine sand to very fine sandy clay loam.

The topography of the Firdale soils varies from level to hilly. The topography is level to very gently sloping over many fields but in other areas deep erosion channels and ravines have left an irregular hilly topography. The soils are well drained, as both internal drainage and surface runoff are rapid.

The Firdale soils were covered completely by woods prior to settlement. The level plains and northern and eastern slopes were covered by a closed stand of aspen, poplar, oak and a wide variety of associated shrubs. Slopes with southern and western aspect are covered by sparse stands of oak and hazel intermixed with mixed prairie grasses.

The Firdale association has been divided into two textural types: (i) the Firdale loams and (ii) the Firdale clay loams.

(i) *Firdale loams* (49,894 acres)

The surface texture of the Firdale loams varies from loamy fine sand to very fine sandy loam. The dominant soil is a Degrading Black which has the following profile features:

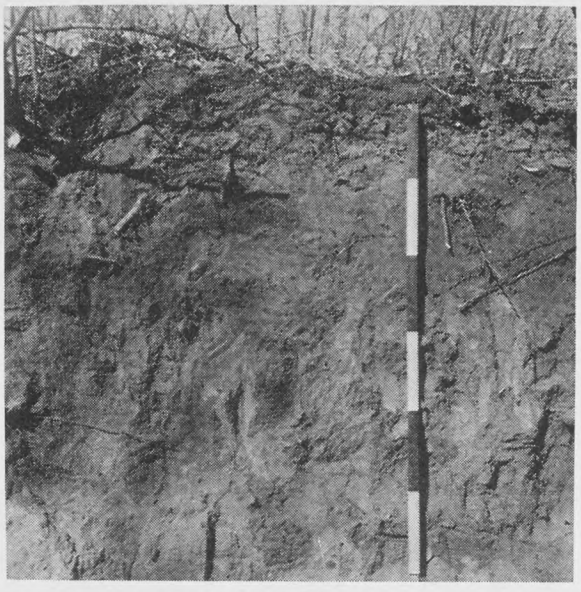


FIGURE 29

Soil profile of the Degrading Black member of the Firdale association developed on loamy fine sand. (Stick interval —6 inches.)

O —Very dark brown leaf mat (1 to 3 inches thick); slightly acid in reaction.

A_1—Very dark grey very fine sandy loam (1 to 3 inches thick); weakly fine granular; very friable; neutral to slightly acid in reaction.

A_2—Dark grey brown loamy very fine sand (4 to 6 inches thick); weakly coarse platy; very friable; slightly to moderately acid in reaction.

A_3—Dark grey brown very fine sandy loam (2 to 5 inches thick); fine subangular blocky; friable; slightly to moderately acid in reaction.

B_1—Brown very fine sandy loam (2 to 3 inches thick); subangular blocky; friable; slightly to moderately acid in reaction.

B_2—Brown to yellowish brown very fine sandy loam (5 to 9 inches thick); subangular blocky; friable to firm; slightly to moderately acid in reaction.

B_3—Brown to brownish yellow loamy very fine sand (4 to 10 inches thick); weakly subangular blocky; very friable; slightly acid to neutral in reaction.

Cca–Light yellowish brown to light olive loamy very fine sand (6 to 15 inches thick); slightly cemented, moderately calcareous.

C —Light yellowish brown loamy very fine sand; laminated; loose; alkaline in reaction.

Associated soils include: Black and Grey Wooded on the well drained sites, and Meadow soils in the bottom of ravines. However, the dominant Degraded Black soils constitute almost the entire acreage of arable soils.

(ii) *Firdale clay loams* (14,822 acres)

The surface texture of the Firdale clay loams varies from very fine sandy loam to clay loam. The dominant soil is a Degrading Black which has the following soil profile features:

O —Very dark brown fibrous leaf mat (1 to 3 inches thick); neutral in reaction.

A_1—Dark grey fine sandy clay loam (1 to 2 inches thick); finely granular; friable; slightly acid in reaction.

A_2—Light grey to greyish brown very fine sandy loam (3 to 5 inches thick); medium platy; friable; slightly acid in reaction.

A_3—Greyish brown very fine sandy clay loam (2 to 6 inches thick); subangular blocky; friable; slightly acid in reaction.

B_1—Brown very fine sandy clay loam (2 to 4 inches thick); strongly subangular blocky; firm; slightly acid in reaction.

B_2—Brown to yellowish brown clay loam (5 to 10 inches thick); strongly medium to coarse subangular blocky; firm; slightly acid in reaction.

B_3—Pale brown very fine sandy clay loam (4 to 10 inches thick); subangular blocky; friable; slightly acid to neutral in reaction.

Cca–Very pale brown very fine sandy clay loam (8 to 12 inches thick); weakly fine granular; friable; moderately calcareous.

C —Light yellow brown to light olive laminated very fine sandy loam; firm; slightly calcareous.

Associated soils include the truncated phase of the Degrading Black soils on the steeper slopes, and Meadow soils along the bottom of ravines.

Agriculture: The productivity of the Firdale soils is dependent largely upon soil texture and topography. The finer-textured Firdale soils are moderately fertile, as they have a fair moisture-retention capacity and a favorable soil reaction. However, organic matter supply is moderately low and most of the soil area is susceptible to severe water erosion. The sandier-textured Firdale soils are relatively low in natural fertility, as they have low moisture-retention capacity and a low reserve of organic

A —Very dark grey loam to clay loam (4 to 8 inches thick); high in organic matter; fine granular; friable when moist, hard when dry; moderately calcareous. Grades sharply into:

Cca–Light brownish grey loam (4 to 8 inches thick); fine granular, very friable when moist, cemented when dry; very strongly calcareous. This horizon often contains an unconforming layer of sand to gravel. Grades into:

C —Light grey to pale brown, loam to clay loam, reworked highly calcareous till; slightly iron stained.

FIGURE 31

Soil profile of the imperfectly drained Rendzina member of the Isafold association. (Stick interval—6 inches.)

ALLUVIAL SOILS

GLADSTONE ASSOCIATION (43,827 acres)

The Gladstone association is made up of immature soils developed on calcareous, medium- to fine-textured alluvial deposits. Surface textures are predominantly clay loams although a range in texture occurs from very fine sandy loam to silty clay.

The topography is level, but the physiographic position which the association occupies is depressional compared to the surrounding terrain. The soils are largely imperfectly drained, as surface runoff is slow and the subsoil is usually saturated by seepage waters from adjacent sandy soils and from the various rivers and creeks which cross the Gladstone soil area. The vegetation of the Gladstone soils prior to settlement was dominantly meadow-prairie and meadow grasses and herbs. Trees common to flood plains grow naturally along the stream channels which traverse the soil area. The trees which remain in natural woodlots along the various streams include oak, elm, ash, Manitoba maple, a variety of willows and some aspen poplar.

The dominant, imperfectly drained associate has a friable, porous "A" horizon that ranges from a few inches in thickness in the weakly developed profiles to seventeen inches in the strongly developed profiles. The "A" horizon blends gradually with the porous "C" horizon which is usually gleyed. In the vicinity of the stream channels, the soils generally are weakly developed and have light-colored, surface horizons, whereas away from the stream channels the soils are more strongly developed and darker in color. The poorly drained soils often are finer textured and more calcareous than the imperfectly drained soils.

Agriculture: The Gladstone soils are moderately fertile. They have good moisture-holding capacity, a fair to good supply of organic matter and, as they are developed on alluvium, the subsoil material is relatively fertile. However, large areas of the soils are periodically flooded in the spring, and the soils are usually calcareous to the surface.

Grain farming is the predominant type of land utilization. The soils also are suited to forage crops, row crops and a wide variety of

fruits common to this climatic region. Forage crops should be part of the cropping system to reduce susceptibility to wind erosion and maintain organic matter supply.

Oakville Association (78,412 acres)

The Oakville soils are developed on slightly calcareous, medium- to fine-textured alluvial sediments. Surface textures range from silty clay loam to clay.

The topography of the Oakville soil area is nearly level. Shallow meandering stream channels traverse the area. Most of the channels are dry except in wet seasons and in periods when the Assiniboine River flood waters reach this area. Soil drainage is imperfect to poor as surface runoff and internal drainage are slow.

The native vegetation on the Oakville soils originally consisted of deciduous woods along the stream channels and tall prairie, meadow-prairie and meadow grass associations away from the creeks. Since settlement, agricultural crops have replaced the original vegetation over most of the area except on the poorly drained Meadow soils and in some of the wooded strips that remain along the streams.

The "A" horizon of the soil profiles is moderately well- to well-developed. The dominant, imperfectly to well-drained soil has a friable, very dark grey surface horizon, which is neutral to slightly alkaline in reaction. The subsoil is pale brown to light olive grey, slightly iron stained and slightly calcareous. A buried profile is usually found within the subsoil which indicates that the surface material is composed of recent sediments. The alluvial sediments are underlain by lacustrine clay deposits of glacial Lake Agassiz.

Associated soils include: imperfectly and poorly drained soils which closely resemble Black-Meadow and Meadow soils in characteristics; slightly degraded variants of the dominant soil; and saline and solonetzic variants of the imperfectly and poorly drained soils.

Agriculture: The better-drained Oakville soils are excellent agricultural soils. They have good water-retention capacity, a good supply of organic matter, favorable reaction, and fairly good drainage. The more poorly drained soils are not as widely adaptable to crops as they usually are slightly calcareous, subject to flooding in wet seasons, and may be salinized.

A wide variety of agricultural crops, such as grain, row crops, roots, garden crops, grasses and legumes, can be grown on the better-drained soils. The imperfectly to poorly drained soils are most suited to grain and forage crops. Particular problems on the wetter soils have been the eradication of horsetail and the low availability of nitrogen in the soil. These problems are especially acute on poorly drained soils. Improvement of soil drainage is one method of ameliorating these problems.

Riverdale Association (21,709 acres)

The Riverdale soils are developed on slightly calcareous, medium-textured, recent alluvial deposits. Surface textures vary from fine sandy loam to silty clay.

The topography is irregularly level to very gently sloping as the alluvial plain is marked by meandering channels, oxbows, levees and river terraces. Some short slopes along the oxbows are too steep for arable culture. Soil drainage is good, as internal percolation and surface runoff are moderately rapid. The vegetation have been largely removed but a considerable acreage of woodlands remains bordering the stream channels. The principle species of trees include elm, ash, basswood, cottonwood and Manitoba maple.

The "A" horizon of the soil profiles, where present, is weakly to very weakly developed. No leaching of soluble materials or degradation is in evidence. The soil materials range from light brownish grey to brown in color. The surface horizons are neutral to slightly alkaline in reaction. The soil in cross section has a laminar or stratified appearance. Dark bands of organic matter occur at irregular intervals in

the profile. Abrupt changes from layers of fine sand to layers of silty clay are common. Generally the coarser textured soils occur adjacent to the stream channels.

Agriculture: The Riverdale soils are highly fertile. They have good moisture-retention capacity, favorable reaction and good internal drainage. Organic matter supply is low at the surface but bands of organic material are distributed throughout the soil to considerable depth.

The Riverdale soil may be utilized for the production of all kinds of agricultural crops. They are especially suited for market gardening and fruit culture. The one problem encountered is the aperiodic flooding of these soils both in the early spring, by excess flash runoff, and during the growing season, when spring runoff from the head waters of the Assiniboine River reaches the Lake Agassiz basin.

MISCELLANEOUS SOILS

TIGER HILLS-HILTON COMPLEX (11,289 acres)

The Tiger Hills-Hilton complex of soils is developed on boulder till of limestone and granitic rock origin. The surface texture varies from loam to clay loam. Stoniness is severe in local areas.

The topography is variable as the soil complex extends over morainic deposits. Sections of the soil area are irregular and the topography is moderately to steeply sloping. In other sites the topography is relatively smooth and gently sloping. Soil drainage is generally good but numerous poorly drained potholes occur in the morainic landscape.

The vegetation is predominantly mixed prairie grasses on the south and west slopes and aspen, oak and hazel woods on the north and east slopes. The well-drained Hilton soil, which has developed under grassland vegetation, is a Black soil; whereas the well-drained Tiger Hills soil, which has developed under woodland vegetation, is a Degrading Black soil.

The well-drained Hilton soil has been described in this report within the description of the Hilton association. A generalized profile of the well-drained Tiger Hills soil may be described as follows:

O —Very dark brown leaf mat (1 to 2 inches thick); neutral in reaction.

A_1—Very dark grey loam (1 to 3 inches thick); finely granular, friable when moist; very slightly acid in reaction.

A_2—Dark greyish brown loam (2 to 5 inches thick); medium platy; friable when moist; slightly acid in reaction.

B_1—Dark brown clay loam (1 to 3 inches thick); strongly subangular blocky; firm when moist; slightly acid in reaction.

B_2—Dark yellow brown clay loam (4 to 6 inches thick); strong subangular blocky; very firm when moist; slightly acid in reaction.

Cca–Very pale brown loam (4 to 6 inches thick); granular; friable; strongly calcareous.

C —Very pale brown, loam boulder till; pseudogranular; firm, strongly calcareous.

Soils associated with the Black Hilton soil and Degrading Black Tiger Hills soil include: Black-Meadow, degrading Black-Meadow, Saline Meadow, Meadow, Peaty Meadow and Degraded Meadow soils. Lacustrine deposits of variable depth are generally encountered over the boulder till in the poorly drained depressions.

Agriculture: The agricultural utilization of these soils depends largely on topography. The soils have a fair moisture-holding capacity. The Tiger Hills soils have a soil reaction favorable to cereal crops but they have a low supply of organic matter. The Hilton soils have a fair supply of organic matter but the cultivated soils are calcareous to the surface.

Grain is grown where the topography is relatively smooth. Areas with rough topography are utilized as grazing land. Water erosion has been severe on the steeper slopes under cultivation. Complete removal of the trees should be avoided as belts of trees left on the contour are effective field boundaries for contour farming. Grasses and legumes grow well on these soils.

ASSINIBOINE COMPLEX (51,354 acres)

The Assiniboine complex consists of variable-textured soils developed upon alluvial deposits along the broad valley floor of the Assiniboine River channel. Textures range from loamy fine sand to clay.

The topography of the Assiniboine complex is irregular. The basin of the Assiniboine River channel in which the soils occur is marked by terraces, oxbows and old abandoned stream courses. The condition of soil drainage is dependent on the topography and texture of the parent material at any particular site. The vegetation along the bottom of the valley is predominantly woods common to flood-plains such as elm, ash, and maple. On the terraces, some oak and hazel occur along with these species. Originally spruce and tamarack occurred along the valley floor but they have been largely depleted by fire and by tree-cutting operations.

The soils in the axial position of the valley are immature and only thin, weakly developed "A" horizons have been formed. More strongly developed "A_1" horizons occur in soils developed on older deposits. Weakly degraded soils are encountered on the valley terraces.

Agriculture: The agricultural utilization of the Assiniboine soils is varied. Generally they are moderately to very fertile. The immature alluvial soils along the valley are very fertile and are excellent agricultural soils if drainage is adequate. The soils on the river terraces are usually coarser in texture and in many areas the topography is too irregular to permit cultivation of large fields. The Assiniboine soils are well suited to a mixed-farming enterprise as grain can be grown on the arable soils and the natural tree growth gives good winter protection for cattle. Rough, nonarable land can be utilized as pasture.

ERODED SLOPES (30,822 acres)

The Eroded Slopes consist of a complex of truncated soils on steep slopes. Texture is extremely variable. The slopes are too steep to be cultivated. Most of the eroded slopes are covered with woodland vegetation. North- and east-facing slopes are heavily wooded with aspen, oak, birch, hazel and other minor species. South- and west-facing slopes are covered by mixed prairie grasses and woodland vegetation, principally scrubby oak and hazel.

Agriculture: The eroded slopes are utilized for grazing, tree growth and wild life. The native vegetation protects these slopes from excessive erosion and provides food and shelter for game birds and animals.

MARSH (62,848 acres)

The Marsh areas consist of very poorly drained soils composed of thin muck and peat deposits overlying variable glacial drift deposits.

The flat depressional areas of Marsh above the Manitoba Escarpment remain very wet due to seepage from the surrounding coarse-textured deposits. Below the Manitoba Escarpment runoff waters collect in the depressional areas and in aperiodic dry seasons these Marsh areas are dry. In the vicinity of Lake Manitoba the level of water in the Marsh area is subject to fluctuations of several feet depending on the level of water in the lake and on the effect of wind tides caused by prolonged northerly winds.

The depth of peat covering the mineral soil is variable, but over most of the areas it is relatively thin. In the Epinette swamp area the underlying mineral horizons are coarse in texture. Alluvial sands and silts occur in the bottom of the eroded channels which rise in the Upper Assiniboine Delta and emerge along the Manitoba Escarpment. In Marsh areas below the escarpment the texture of mineral material is usually similar to the texture of the adjacent mineral soils.

Above the escarpment, the Marsh areas are covered by reeds and sedges along with some willow and tamarack which grow principally along the edges of the Marsh. Below the escarpment the vegetation on the Marsh areas is dominantly sedges and reeds.

Agriculture: The Marsh areas are best suited to wild life, although a small percentage of the area is suitable for hay and pasture. The utilization of the Marsh areas is dependent upon the local and seasonal drainage conditions.

E. ESTIMATED SUITABILITY OF SOILS FOR AGRICULTURAL USE

The estimated suitability of the soils of the Carberry area for various purposes is shown in Table 8. The estimates in this table are based on general observations and on a study of the characteristics expressed in the respective soil profiles. In seasons of above average precipitation, many of the soils will give better returns than are indicated, but in periods of severe drought, even the better soils may give less satisfactory returns. It should also be observed that the respective average estimates must be modified on some farms to conform with local variations. Further, the estimates given are not absolute values based on crop yield data, but they represent the considered opinion and field observations of the soil surveyors involved.

F. LAND-USE CAPABILITY CLASSES

The soils which occur in the Carberry map sheets can be grouped into land-use capability classes on the basis of observed characteristics such as soil depth and texture, erosion, stoniness, salinity, drainage and fertility. Brief definitions of the eight recognized land-use capability classes, together with a list of the soils which may be placed in each class, are given under the following headings:

(a) *Land Suited to Arable Culture:*

Class I—Land of very good productivity. Highly productive soils on land that is level to very gently sloping. Some local areas may need clearing, provision for water control, and fertility maintenance. However, good farming methods are essential to keep the soil in good condition and to control weeds, diseases and insect pests. The following soils may be listed in this category:

Riverdale association
Oakville, moderately well-drained associates
Portage association

Class II—Land of good productivity. Good soils on land that is level to gently sloping. Some areas in certain soil associations may be slightly stony, some may require moderate drainage, and some may be subject to wind and water erosion or may require improvement in workability. The following soils may be listed in this category:

Holland association
Wellwood association
Harding association
Carroll association
Glenboro association
Burnside association
Marquette association
Gladstone association
Newdale undulating phase
Rathwell association
Red River associate
Beresford association

Class III—Land of moderate productivity. Soils in this land class are limited in productivity due to one or more of a number of factors such as: susceptibility to wind and water erosion, limited fertility, soil drought (due to sandy texture or to physiological drought resulting from excess lime carbonate), salinity, stoniness, poor drainage, etc. These limitations may be of the same kind as those noted in Class II land, but the limiting factors are effective to a greater degree. The following soils may be listed in this category:

Lakeland association
Holland-Stockton complex
Newdale smooth phase
Firdale clay loams
Assiniboine complex
Arden association
Woodlands complex
Osborne associate
Oakville poorly drained associates
Firdale loams

Souris association
Almasippi loamy sands
Stockton fine sandy loams
Stockton fine sandy loams, till substrate phase
Westbourne association
Hilton association

(b) *Land Suited to Limited Arable Culture:*

Class IV—Land of limited productivity. Soils in this class are best suited for hay, pasture, or forestry, but may be utilized for crop production periodically. Limitations of this class are excessive stoniness, low fertility, unfavorable topography, poor drainage, or extreme susceptibility to wind erosion. The following soils may be listed in this category:

Tiger Hills-Hilton complex
Miniota sandy loams
Isafold association
Almasippi sands
Stockton loamy sands (exclusive of dune sands)

(c) *Land Not Generally Suited to Arable Culture:*

Class V—Land suitable chiefly for pasture, hay or forestry. The soils in this class are usually on level to gently sloping topography, but they are not suited for general crop production because they are either stony, salinized, calcareous, infertile, gravelly, coarse textured, or poorly drained. The following soils may be listed in this category:

Marringhurst association
Miniota sands

Class VI—Land suitable for hay, grazing or tree production with limitations. These limitations arise from the soils being infertile and either poorly drained and inaccessible during part of the summer season or very droughty due to coarse texture and steeply sloping topography. The following soils may be listed in this category:

Sand dunes

Class VII—Land suited for grazing or forestry with major limitations. The land in this class requires extreme care to prevent erosion, destructive burning or over-grazing. Such land may be steep, rough, hilly, and highly susceptible to erosion. Generally this class is most suited to forestry. The following soils may be listed in this category:

Eroded slopes

Class VIII—Land suited only for wild life and recreation. This land may be extremely rough, rocky or waterlogged. The following soils may be listed in this category:

Marsh

TABLE 8

Estimated Suitability of Soils in the Carberry Map Area for Various Purposes

Symbols: E = Excellent; E-G = excellent to good; G-E = good to excellent; G = good; G-F = good to fair; F-G = fair to good; F = fair; F-P = fair to poor; P-F = poor to fair; P = poor; VP = very poor; V = variable; X = not naturally favorable, but could be utilized if suitable corrective measures were adopted; ++ = well adapted; + = suitable; +− = more or less suitable; −− = not suitable, or of relatively low value.

Note: The following estimates are given as a guide to the average suitability of each soil association for land use in average seasons.

Soil Designation	Cultivated Land								Unbroken Land			Forestry and Field Windbreaks
	Grain Crops		Intertilled Crops			Cultivated Hay and Pasture Crops		Gardens and Fruits	Native Hay	Grazing	Wild Life	
	Wheat	Coarse Grains	Fodder Corn	Seed Corn	Roots and Potatoes	Grasses	Legumes					
Agassiz Association	(V)P	(V)P	(V)P-F	(V)P	(V)P-F	(V)F	(V)P-F	(V)P	(V)P	(V)F	+−	−−
Almasippi Association:												
Sands	P	F-P	F	P-F	F	F-G	G	F	F	F-G	+−	++
Loamy sands	F	F	G	F	F	G	G	F	F	G	+−	++
Arden Association	G-F	G	(X)F	(X)P	F	F-G	F-G	F	F	F	+−	+−
Assiniboine Complex	(V)E-P	(V)E-P	(V)E-P	(V)G-P	(V)E-P	(V)E-F	(V)E-F	(V)E-F	(V)G-P	(V)E-F	++	++
Beresford Association	G	G	G	(X)F	G-F	G	G	G-E	G	G	−−	+
Burnside Association	G-E	G-E	G	G-F	G	G	G-E	G	G	G	−−	+
Carroll Association	G-E	G	G	F	G	G	G-E	G-E	G	G	+−	++
Firdale Association:												
Loams	F-G	F-G	G	F	G	G	G-E	E	F-G	F-G	++	++
Clay loams	G-E	G	G	F	G	G-E	E	E	G	G	++	++
Gladstone Association	G	G-E	G	F	G-E	G-E	G-E	G-E	G	G	++	++
Glenboro Association	G-E	G-E	G-E	G-F	G	G	G-E	G-E	G	G	+−	+
Harding Association:												
Harding clay	E-G	E	G	(X)F	G	G-E	G-E	G-E	G	G	+−	+
Harding clay, till substrate phase	G-E	G-E	G	F	G-F	G	G	G	G	G	+−	+
Hilton Association	F	F	F	−−	F-P	F-P	F-P	V	V	V	−−	−−
Holland Association	E-G	E-G	E-G	F-G	G	G-E	G-E	E	G	G-E	+−	+
Holland-Stockton Complex	G	G	G-E	F	G-F	G	G-E	G	G	G	+−	+
Isafold Association	(V)P-F	(V)F	(X)P	(X)P	(V)P-F	F-G	(V)F-G	(V)P-F	F	F-G	+−	−−
Lakeland Association	F-G	G-F	F-G	(X)F	F-G	G-F	G	F-G	F-G	F-G	−−	−−
Marquette Association	G	G-E	G-F	F	G-F	G	G	G-F	G-E	G	−−	+
Marringhurst Association	P-F	P	P-F	P	VP	P-F	P-F	P	P-F	F	+−	−−
Miniota Association:												
Sands	P-F	P	P-F	P	P	P-F	F	P	P-F	F	+−	+−
Sandy loams	F	F-P	F	P-F	P-F	F	F-G	P-F	F	F-G	+−	+

TABLE 8 (Cont'd)

Estimated Suitability of Soils in the Carberry Map Area for Various Purposes

Symbols: E = Excellent; E-G = excellent to good; G-E = good to excellent; G = good; G-F = good to fair; F-G = fair to good; F = fair; F-P = fair to poor; P-F = poor to fair; P = poor; VP = very poor; V = variable; X = not naturally favorable, but could be utilized if suitable corrective measures were adopted; ++ = well adapted; + = suitable; +− = more or less suitable; −− = not suitable, or of relatively low value.

Note: The following estimates are given as a guide to the average suitability of each soil association for land use in average seasons.

Soil Designation	Cultivated Land								Unbroken Land			Forestry and Field Windbreaks
	Grain Crops		Intertilled Crops			Cultivated Hay and Pasture Crops		Gardens and Fruits	Native Hay	Grazing	Wild Life	
	Wheat	Coarse Grains	Fodder Corn	Seed Corn	Roots and Potatoes	Grasses	Legumes					
Newdale Association:												
Smooth phase	G	G	F	(X)P	F	G	G	G	G-F	G	+−	+−
Undulating phase	G-E	G-E	F	(X)P	G-F	G-E	G-E	G-E	G-F	G	+−	++
Oakville Association:												
Moderatey well drained associates	E	E-G	E	E-G	E	G-E	G-E	E-G	F	F	−−	+
Poorly drained associates	(V)G	(V)G	(X)F	(X)P	(X)F	F-G	(V)F-G	(X)F-G	G	G	−−	+−
Portage Association	E-G	E	E	G-F	E	E	E	E	G	G	+−	+
Rathwell Association	G-E	G-E	G	F-G	G	E	G-E	G-E	G	G	+−	++
Red River Association:												
Red River associate	G	G-E	G	G-F	F-G	G	G	G	G	G	−−	+−
Osborne associate	G-F	G-F	(X)F	(X)P	(X)F	G	(V)F-G	(X)F	G-F	G-F	−−	−−
Riverdale Association	E	E	E	E	E	G	G	E	−−	−−	−−	++
Sand dunes	−−	−−	−−	−−	−−	P	P	P	P	P-F	++	+−
Souris Association	F	F	G-F	P-F	F-P	F	G-F	F-P	P-F	F	+−	+
Stockton Association:												
Loamy sands	F-P	P-F	F	P	F-P	F	F	P-F	F	F	+−	+
Fine sandy loams	F-G	F	F-G	P-F	F	F	F-G	F-P	F	F	+−	+
Fine sandy loams, till substrate phase	F	F	F	P	F	F-G	F-G	F	F	F	+−	+
Tiger Hills-Hilton Complex	(V)P-F	(V)P-G	(V)P-F	P	P-F	F	G-F	F	F	F-P	++	+
Westbourne Association	P-F	F	P	P	P	F	F	P	F	F	+−	−−
Woodlands Complex	(V)F	(V)F	(V)F-P	P	(V)F	F-G	(V)G-F	(V)F	F-G	G-F	+−	−−
Wellwood Association:												
Wellwood loams	E	E-G	G	F-P	G-E	G-E	G-E	E	G	G	+−	+
Wellwood loams, till substrate phase	G-E	G-E	G-F	P	G-F	G-E	G-E	G-E	G	G	+−	+
Marsh	−−	−−	−−	−−	−−	−−	−−	−−	−−	−−	++	−−
Eroded Slopes	−−	−−	−−	−−	−−	−−	−−	−−	−−	−−	++	++

Part IV.

LAND UTILIZATION

A. HISTORY OF SETTLEMENT

The earliest recorded inhabitants of the Carberry map area were Indians of the Assiniboine, Cree and Sioux tribes who were largely nomadic in nature and relatively few in number. The land utilization at the time may be classed as wild-life regime and the prairies produced the beast and fowl necessary to the Indians' well being.

Henry Hudson's discovery of Hudsons Bay in 1610 was the beginning of a long succession of explorers, fur traders and settlers in the "new world". In 1670 the Hudsons Bay Charter was issued in England "To The Governor and Company of Adventurers of England trading into Hudsons Bay mainly to exploit the fur trade in the northern portion of the continent." La Verandrye was the first white man to traverse the Carberry map area, when in 1738 he ascended the Assiniboine River and established Fort la Reine 21 miles east of Portage la Prairie, which was moved the next year to near the present site of Portage la Prairie.* This was the first of a succession of forts and trading posts built along the Assiniboine River by the rival Hudsons Bay and Northwest Companies for trade with and protection from the Indians.

The first settlers in Manitoba were a group of Scottish and Irish immigrants who arrived on the Red River in 1812 under the sponsorship of Douglas, Earl of Selkirk. They were forerunners of the group of immigrants generally known as the Selkirk colonists. These pioneers established a very limited subsistence type of agriculture along the Red and Assiniboine rivers which was maintained for about sixty years.

The complexity of the land survey system which occurs along the rivers in the eastern portion of the Carberry map area is linked with the physical necessities of land tenure in early days. In July, 1817 Lord Selkirk signed a treaty with the Indians which, according to the Indian's version, gave Lord Selkirk the land back from the river banks as far as daylight could be seen under the belly of a pony standing on the level prairie.* This land was then divided into river lots, which were grouped into parishes bearing names of Scottish and French saints. When the Province of Manitoba was formed in 1870 the Federal Government began a quadrilateral system of survey on the Crown lands in which townships of 6 x 6 miles were subdivided into 36 sections of one square mile or 640 acres in size. Each section was subdivided into four quarter sections containing 160 acres. Consequently, on the soil map two systems of survey are encountered.

By 1854 the land along the river to Portage la Prairie had been laid out in river lots and an Anglican mission had been established at Westbourne. In 1871 the first settlers arrived along the Whitemud River and settled as far west as Third Crossing (Gladstone). By 1877 the first white settlers, the Lambert brothers, had reached the vicinity of Brandon, but not until 1879 when Reverend Roddick and the McVicar brothers settled in the Brandon area did any number of settlers arrive. By 1880 the railroad had passed Portage, reaching as far as Austin or MacGregor and in 1881 it was completed to Brandon and beyond. A new group of settlers arrived with each train to find and take up land under the Homesteads Act.

By 1890 most of the accessible lands had been homesteaded and the major influx of settlers was passed. Considerable areas of land remained which were undesirable due to poor drainage, stoniness or limited fertility. Many of these areas have been brought under cultivation in more recent times during periods of peak agricultural prosperity when land was in great demand and the cost of drainage and clearing could be absorbed.

*Kavanaugh, M., "The Assiniboine Basin". Winnipeg Public Press, 1946.

*Healy, W. J. "Women of Red River", Russell Lang and Company, 1923.

B. AREA AND PRESENT USE OF FARM LAND

The area and present use of land in the Carberry map area of Manitoba is reflected in the official figures contained in the Dominion census and Provincial crop reports. The number of farms, acreage held as farms, and the farm land in percent of total municipal acreage are given in Table 9 for the years 1941 and 1951 respectively.

TABLE 9

Number and Area of Farms by Municipalities in Carberry Map Area. Dominion Census Data for 1941 and 1951.

Municipalities	Number of Farms	Acres in Farms	Farm Land in Percent of Total*
	HELD AS FARM LAND IN 1941		
Grey	658	221,032	95.9
Portage la Prairie	1,288	389,290	79.0
Cornwallis	289	105,798	80.1
North Cypress	490	211,439	73.7
South Cypress	287	129,746	49.0
Elton	352	136,070	98.4
North Norfolk	733	252,182	91.2
South Norfolk	506	154,811	87.3
Oakland	299	134,380	97.2
Victoria	290	109,623	59.7
St. Francois Xavier	113	45,589	93.0
Woodlands	448	141,810	52.7
Langford	312	117,658	87.1
Westbourne	682	238,286	77.9
Odanah	248	88,807	97.2
Cartier	270	130,003	99.2
Lansdowne	403	143,407	77.7
TOTAL	7,668	2,749,931	
	HELD AS FARM LAND IN 1951		
		**	
Grey	574	229,795	99.7
Portage la Prairie	1,196	418,596	84.9
Cornwallis	235	104,653	79.3
North Cypress	468	221,191	77.1
South Cypress	251	138,902	52.6
Elton	352	137,990	99.8
North Norfolk	660	259,151	93.7
South Norfolk	448	165,694	93.5
Oakland	269	137,534	....
Victoria	264	113,250	61.7
St. Francois Xavier	107	45,730	93.3
Woodlands	437	177,337	65.9
Langford	277	130,360	94.3
Westbourne	650	293,804	96.0
Odanah	209	91,204	99.8
Cartier	259	137,470	....
Lansdowne	377	158,863	86.2
TOTAL	7,033	2,961,524	

*Taken from "Statistical Information Respecting The Municipalities of The Province of Manitoba".

**The area occupied by farms reported for each municipality in 1951 represents the area of land operated by farmers whose headquarters are within the municipal boundaries. Therefore the area of farm land in the municipal units may be greater or less than the actual farm area located within the municipal boundaries.

An increase in the total acreage held as farms has accompanied a considerable decrease in the number of farm operators. Thus farm units have gradually become larger. Although there has been an increase in land held as farms in all of the municipalities, the greatest percentage increase has occurred in Westbourne and Woodland municipalities. This expansion is largely the result of the reclamation of problem soil areas during a period of stimulative economic conditions.

The condition or present use of farm lands is given in Table 10. The item "other improved land" includes areas of barnyards, lanes and roads. It also includes any land that is lying idle, being neither summerfallowed nor cropped, and new breaking that had not yet been cropped. The item "other unimproved land" includes areas of natural pasture or hayland that had not been cultivated, brush pasture, grazing or waste land, sloughs, marsh, and rocky land, etc.

The average number of acres per farm in each of the municipalities has been calculated from the Census of Canada data for 1951. The size of farm common to this area appears to be the one-half section or three-quarter section.

Grey ..... 388 acres
Portage la Prairie ..... 350 acres
Cornwallis ..... 445 acres
North Cypress ..... 473 acres
South Cypress ..... 553 acres
Elton ..... 392 acres
North Norfolk ..... 393 acres
South Norfolk ..... 370 acres
Oakland ..... 511 acres

TABLE 10

Condition of Farm Land by Municipalities in Carberry Map Area
Dominion Census Data 1951

Municipalities	Improved Land		Unimproved Land	
	Crop and Fallow Land Plus Seeded Pasture in Percent	Other Improved Land in Percent	Woodland in Percent	Other Unimproved Land in Percent
Grey	78.18	1.53	7.46	12.83
Portage la Prairie	71.14	1.88	8.30	18.67
Cornwallis	61.43	1.40	6.84	30.33
North Cypress	59.29	1.69	4.46	34.56
South Cypress	56.73	1.63	13.69	27.96
Elton	76.09	2.05	3.09	18.76
North Norfolk	62.55	1.68	7.18	28.59
South Norfolk	63.04	1.58	11.74	23.63
Oakland	69.19	1.55	5.93	23.33
Victoria	59.62	1.48	7.12	31.77
St. Francois Xavier	78.83	.81	8.74	11.63
Lansdowne	56.25	2.50	10.09	31.16
Woodlands	31.73	2.43	14.25	42.59
Langford	60.95	1.96	3.52	33.56
Westbourne	69.45	2.14	7.76	20.66
Odanah	60.63	1.40	1.34	36.64
Cartier	91.12	1.65	3.48	3.75

Victoria ..... 429 acres
St. Francois Xavier ..... 427 acres
Woodlands ..... 406 acres
Langford ..... 471 acres
Westbourne ..... 452 acres
Odanah ..... 439 acres
Cartier ..... 520 acres
Lansdowne ..... 422 acres

C. TYPE OF AGRICULTURE FOLLOWED

The predominant type of agriculture followed in the Carberry map area is indicated by the extent and type of crops grown and by the number and kind of livestock kept. Climatic and economic conditions considerably affect the annual and cyclic variations in the type of agriculture followed. However, the data presented herewith, which is specific to the year 1951, for the various municipalities reflect the form of agricultural production.

Crop Acreages: The total crop acreage figures by district units are not as easily interpreted as figures by farm units. To simplify the official crop acreage data, the total figures for the crops and land use in the municipalities have been calculated as the average acres per section of 640 acres. By thus expressing the crop acreage figures as acres per section, the general use made of the arable land in this area can be visualized more readily.

The average acreage of the various crops per section of land is presented in Table 11. The largest part of the available improved land is utilized for grain production and as fallow land preparatory to grain. In 1951, 28 percent of the land devoted to grain growing within the municipalities was in fallow; 21 percent in wheat; 26 percent in barley; 17.5 percent in oats; 6 percent in flax; and 1.5 percent in rye and mixed grains. These 1951 percentage figures indicate that a crop sequence of one year fallow, followed by 2 or 3 years of grain, is common practice. Field roots occupy a small acreage, principally in the Portage la Prairie and Cartier municipalities. The acreage of potatoes indicates that this crop is grown chiefly for local consumption, except in Cornwallis and St. Francois Xavier municipalities where a small acreage is used for commercial purposes.

Yield data reported by municipalities is not available. However, the annual yields of cereals in the Manitoba Crop Reporting District No. 8 (Carberry), (which includes the municipalities of Elton, Cornwallis, Oakland, North Cypress, South Cypress, North Norfolk, South Norfolk, and Victoria) are submitted in Table 12 as a record of annual crop yields for the central and south-western section of the Carberry map sheet area. Over a period of 33 years there has been a wide variation in the

TABLE 11

Utilization of Farm Lands, Carberry Map Area
Data For Each Municipality Expressed as Acres Per Section of Farm Land (640 Acres)
Dominion Census Data 1951

Municipality	Fallow	Wheat	Barley	Oats	Rye	Flax	Mixed or Other Grains	Cultivated Hay and Pasture	Other Fodder Crops	Potatoes	Other Field Roots	Other Field Crops	Farmsteads, Gardens, etc. by Difference	Woodland	Marsh and Wasteland
Grey	92.5	107.6	65.0	102.3	3.0	49.0	5.5	74.0	2.2	0.3	—	0.6	8.2	47.7	82.1
Portage la Prairie	101.8	77.4	165.5	54.4	0.4	15.8	11.2	23.4	2.1	0.6	2.1	0.6	12.1	53.1	119.5
Cornwallis	98.9	66.4	52.7	85.1	4.0	20.3	3.0	55.0	4.7	2.1	0.1	—	10.0	43.7	194.0
North Cypress	102.9	88.8	53.9	68.3	3.4	22.7	0.7	33.2	4.4	0.2	—	0.9	10.9	28.5	221.2
South Cypress	100.6	74.0	62.4	48.9	6.5	12.0	1.2	53.8	3.1	0.6	—	—	10.4	87.6	178.9
Elton	157.1	121.7	106.9	60.7	0.4	16.2	1.1	22.4	2.2	0.3	—	—	11.1	19.8	120.1
North Norfolk	90.1	67.4	43.8	111.1	2.7	26.6	2.5	52.8	3.4	0.2	—	1.5	9.1	45.9	182.9
South Norfolk	89.0	80.6	79.2	54.6	2.7	49.3	2.5	42.2	3.1	0.4	—	0.3	9.8	75.1	151.2
Oakland	133.6	107.0	110.7	48.2	3.1	18.8	0.7	17.5	2.5	0.2	—	—	10.5	37.9	149.3
Victoria	100.9	68.5	103.7	46.1	4.9	20.5	1.3	28.7	6.1	0.3	—	0.5	9.6	45.6	203.3
St. Francois Xavier	126.5	56.1	226.9	56.7	—	10.6	5.8	14.3	0.8	2.2	0.3	0.7	8.9	55.8	74.4
Woodlands	55.9	32.7	85.9	56.1	—	9.7	3.7	13.3	2.4	0.3	—	0.5	15.3	91.2	273.0
Langford	103.7	81.0	77.3	53.5	3.5	24.9	0.8	37.1	6.4	0.3	—	—	14.3	22.5	214.8
Westbourne	87.7	44.5	95.0	105.7	—	46.1	2.6	59.5	2.9	0.2	—	—	14.0	49.6	132.2
Odanah	121.2	97.9	104.6	32.4	—	20.1	1.2	9.2	0.8	0.1	—	—	9.5	8.5	234.5
Cartier	147.9	128.7	167.4	77.2	0.5	22.1	7.7	24.1	0.3	0.5	4.8	0.6	12.3	22.0	23.9
Lansdowne	95.9	44.7	54.8	82.8	0.5	43.8	1.8	30.8	4.4	0.2	—	—	16.3	64.9	199.4
Average	106.5	79.1	97.4	67.3	2.1	25.2	3.1	34.8	3.0	0.5	0.4	0.4	11.3	47.0	162.0

FIGURE 32

Over 90 percent of the cultivated land is utilized for grain production.

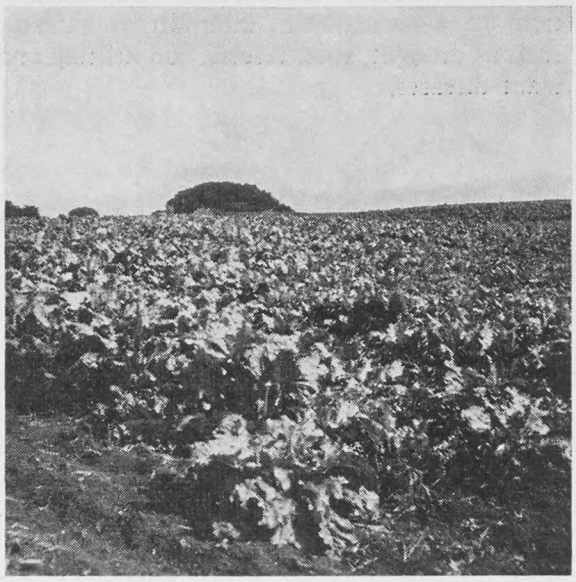


FIGURE 33

Specialized crops are grown in areas close to markets. The sugar beets above are processed at Winnipeg.

FIGURE 34

Jack pine plantation on Black well-drained sandy soils. The natural vegetation is the tall prairie grasses seen in the foreground.

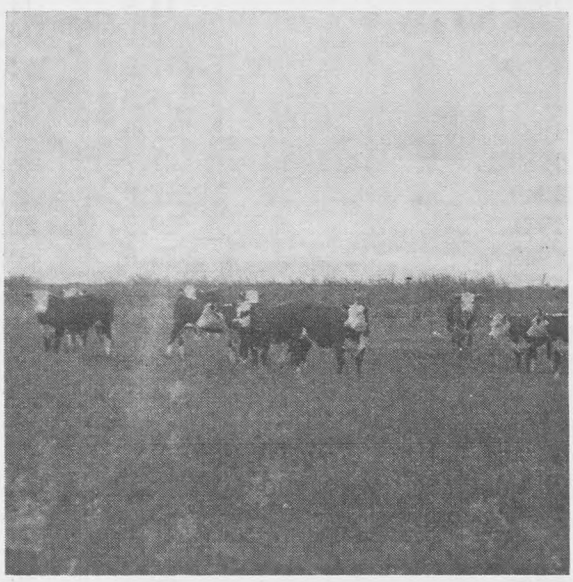


FIGURE 35

Coarse-textured or poorly drained soil areas which are non-arable may be utilized for permanent hay and pasture land.

yield of wheat and other cereals. These fluctuations have been due to intermittent hazards, such as drought, rust, insects, soil drifting and plant diseases.

Yield figures for the Portage la Prairie-Elm Creek area, which is outside of crop reporting district No. 8, may be expected to be somewhat higher than those presented in Table 12.

TABLE 12

Annual Yields of Cereals in Manitoba Crop Reporting District No. 8 (Carberry) 1921-1953 (33 years)

Year	Wheat	Oats	Barley	Fall Rye	Spring Rye	Flax
1921	10.7	18.9	15.4	14.5	12.2	7.8
1922	16.1	38.1	28.7	19.2	11.4	12.5
1923	9.5	29.5	20.7	13.9	10.0	9.4
1924	17.5	34.4	30.2	20.1	13.9	10.8
1925	19.6	37.3	27.4	17.0	14.1	11.4
1926	23.4	34.7	31.4	16.6	15.9	11.5
1927	11.1	13.6	24.2	13.7	10.4	9.6
1928	20.8	38.7	29.3	15.5	16.6	11.7
1929	12.5	19.2	17.3	13.6	9.3	7.2
1930	17.9	30.1	23.9	15.9	12.3	8.8
1931	9.9	14.5	14.1	10.6	8.8	5.1
1932	16.3	22.4	17.0	11.8	10.3	5.4
1933	13.2	18.5	13.6	10.4	11.0	6.8
1934	14.9	14.6	12.8	9.6	8.0	6.9
1935	6.0	19.9	19.3	15.6	14.6	8.8
1936	11.9	14.9	15.5	10.5	8.2	5.6
1937	15.2	34.6	24.3	15.8	14.6	8.9
1938	17.6	29.0	23.1	14.3	12.2	7.9
1939	21.7	28.7	22.9	14.8	13.8	8.5
1940	17.8	25.2	19.2	13.4	13.8	8.3
1941	19.5	30.0	23.5	17.0	16.8	9.6
1942	25.6	50.0	38.0	19.0	20.0	8.6
1943	24.0	38.0	32.3	18.5	15.0	10.0
1944	22.0	41.0	29.0	15.0	16.0	12.3
1945	18.9	30.7	24.7	16.0	15.0	10.0
1946	23.9	35.0	27.0	14.2	14.0	10.0
1947	19.5	27.5	20.7	16.0	13.0	9.6
1948	23.5	39.8	29.5	17.6	16.0	8.8
1949	18.0	27.5	20.0	17.2	13.0	8.5
1950	18.6	43.0	32.0	14.6	14.0	8.0
1951	21.1	28.8	23.0	14.5	12.1	7.0
1952	26.0	40.4	32.0	17.6	16.3	10.3
1953	25.1	38.8	27.0	19.0	15.0	9.6
Mean of 33 Years	17.9	29.9	23.9	15.2	14.6	8.9

Numbers of Livestock: A considerable number of livestock are kept throughout the Carberry map area. The data in Table 13 presents a picture of the numbers and distribution of livestock per section of farm land in each municipality.

TABLE 13

Average Number of Horses, Cattle, Sheep, Swine and Poultry by Municipalities in Carberry Map Area, Manitoba, Expressed as Average Numbers Per Section of Farmland (640 Acres) Dominion Census Data 1951

Municipality	Horses	Cattle		Sheep	Swine	Poultry	
		Milk Cows	Other Cattle			Chickens	Other Poultry
Grey	3.5	13.5	10.4	5.6	13.6	85	205
Portage la Prairie	3.5	7.0	11.2	1.0	12.8	78	189
Cornwallis	4.8	13.9	18.7	4.5	16.0	70	152
North Cypress	3.5	4.8	18.8	3.1	8.1	39	94
South Cypress	4.3	8.0	19.1	.6	11.7	48	96
Elton	3.4	9.0	14.9	.3	10.6	78	175
North Norfolk	5.1	11.1	18.0	6.1	10.3	72	170
South Norfolk	4.5	9.6	11.8	2.3	8.9	60	135
Oakland	4.0	5.4	15.4	.7	6.4	40	85
Victoria	5.0	8.9	15.7	.7	9.8	68	86
St. Francois Xavier	1.6	7.7	6.2	—	9.3	67	275
Woodlands	4.6	12.6	19.2	2.1	10.8	66	154
Langford	3.6	8.0	12.5	.9	14.8	52	131
Westbourne	4.0	6.7	18.9	2.9	10.8	51	127
Odanah	2.6	5.8	10.3	9.8	10.1	48	102
Cartier	1.6	6.5	2.6	1.3	31.5	100	302
Lansdowne	4.7	9.4	15.2	0.9	13.8	48	114

D. GENERAL OBSERVATIONS

The major enterprise on farms in the Carberry map area is grain production. A considerable degree of diversification is practiced in areas where returns from grain production are likely to be inadequate to meet the financial needs of the farm family. However, diversification of farm enterprises is largely restricted because of a lack of adequate demand for milk and other livestock products. Considerable variety in field crop production has been introduced in recent years in the Portage-Elm Creek area where field peas, sugar beets and to a lesser extent potatoes, sunflowers and canning crops have been produced for the commercial trade. There is some demand for market garden crops around the urban centres of Portage la Prairie (population 8,511) and Brandon (population 20,598). Numerous other towns and villages create a minor market for agricultural products, including: Neepawa (population 2,895), Minnedosa (population 2,085), Carberry (population 912), and Gladstone (population 828).

In the past there has been considerable fluctuation in land use within the Carberry map sheet area. A large portion of the marginal land which occurs in the Upper and Lower

Assiniboine Delta has been cropped only intermittently due to the vicissitudes of climate and economic conditions. A suitable and more permanent land-use policy for these areas awaits only an adequate outlet for animal products such as beef, milk and butter. Minor variations in land use among cereal grains and flax can be expected in the grain producing areas due to climatic, biological and economic factors. During the past few years barley has become the most prevalent crop in the Portage-Elm Creek area as it allows better control of wild oats and usually yields satisfactorily from late seeding.

Wind and water erosion have occurred to a greater or lesser degree over the entire Carberry map area. The grain-fallow rotations which constitute the general system of arable culture followed, are conducive to continual accelerated erosion. Wind erosion is especially severe in the sandy soils stretching from Gladstone to Carman, as well as on the sandy textured soils of the Upper Assiniboine Delta. Water erosion is severe on the medium textured soils above and adjacent to the Manitoba Escarpment, which lies on a general line with the villages of Edrans, Firdale, Sydney and Lavenham. The description of the soil problems for each soil association should be carefully noted and the proper soil conservation practices initiated where required in order that the productivity of the good soils in this area be maintained.

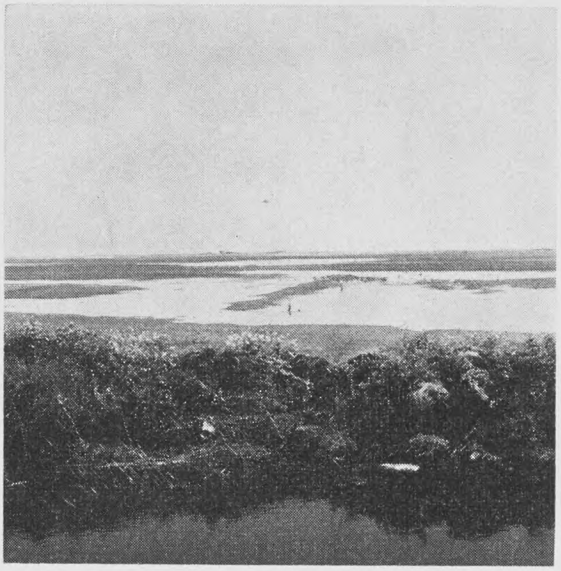


FIGURE 36

Surface flooding of Westbourne soils. In wet seasons flooding is common on the clay-textured soils below the Manitoba Escarpment.

FIGURE 37

Legume crops improve soil tilth and supply nitrogen for the following cereal crops.

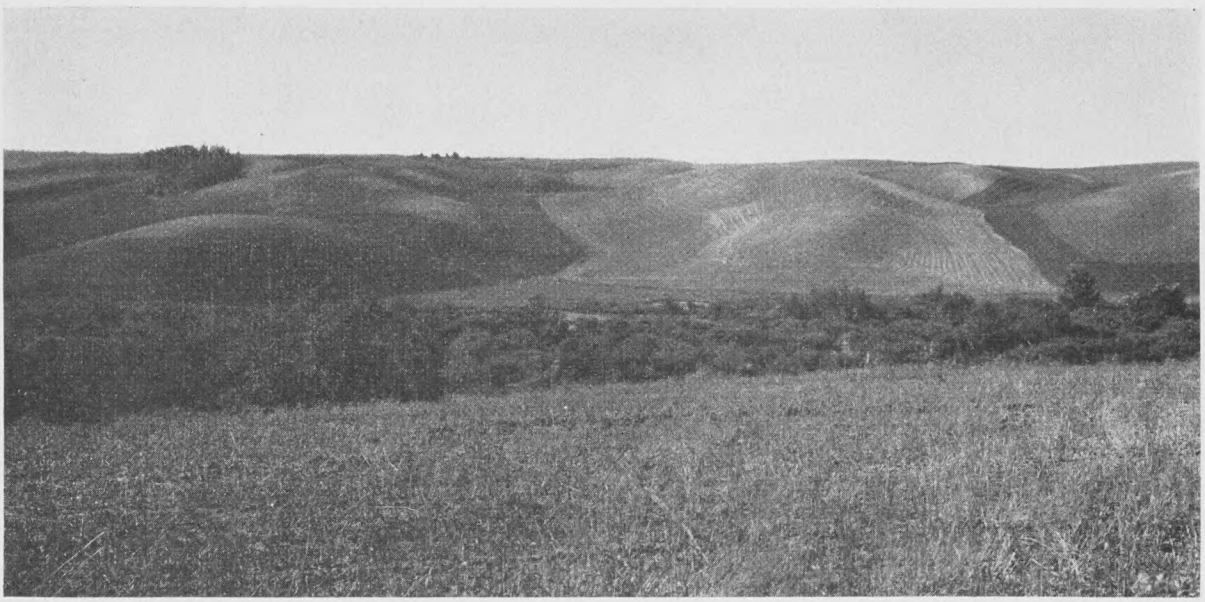


FIGURE 38

The cultivated slopes of the Firdale soils are very susceptible to soil erosion by runoff water. Seeding of steep slopes to permanent forage crops, contour farming, stabilization of gullies, and the use of forage crops in the crop rotation are needed to control soil erosion on this type of topography.

Appendix

CHEMICAL AND PHYSICAL ANALYSES

Chemical and physical analyses of surface soils and soil profiles are presented in Tables 14, 15 and 16. These analyses provide information concerning soil development and have some value as indications of the comparative levels of natural soil fertility.

The samples for profile analyses were obtained from representative virgin sites. Where possible, the surface samples were obtained in sample pairs from virgin sites and adjacent cultivated fields.

The soil textural classes as utilized during the report and in the tables are based on a modified chart of Davis and Bennett, U.S.D.A. Circular 39 as published in "The Soils of Manitoba" by J. H. Ellis, Economic Survey Board, Province of Manitoba.

The physical and chemical methods followed in the analyses of surface and profile samples are as follows:

MECHANICAL ANALYSIS—A modification of the Troell Dispersion method and the Olmstead Pipette method was used. The soil was oxidized with NaBrO and dispersed with Na_2CO_3.

MOISTURE EQUIVALENT—Briggs and McLane method. Am. Soc. of Agron., Vol. 2: p. 139.

ORGANIC CARBON AND INORGANIC CARBONATES —A modification of the methods of Adams and Waynick was used.

Adams—J. Ind. and Eng. Chem., Anal. Ed. Vol. 6: 227.

Waynick—J. Am. Soc. Agron., 28-337-351. 1936.

NITROGEN — The Kjeldahl-Gunning Arnold method was followed. A.O.A.C. 3rd Ed. 1930.

REACTION—The pH of soils was determined using the quinhydrone electrode as described by Bulman and Tooborg-Jensen. Trans. of the 2nd Comm. of I.S.S.S., Vol. B: 236.

AVAILABLE PHOSPHATE AND POTASH — The Merkle method was followed as described in Bull. 398., Penn. State College.

TABLE 14

ANALYSES OF REPRESENTATIVE SOIL PROFILES

Depth	Horizon Designation	Moisture Equivalent	Organic Carbon	Nitrogen	C/N Ratio	Percent CO_3	Reaction (pH)
MINIOTA LOAMY COARSE SAND, WELL-DRAINED ASSOCIATE							
0 - 8	A	11.7	1.91	.15	12.7	0.0	7.1
8 - 14	AB	4.3	.53	.05	10.6	0.0	7.0
14 - 24	B	2.6	.20	.01	20.0	0.0	6.9
24 - 30	C	3.8	.20	.01	20.0	0.0	6 9
30 - 36	C	2.6	.17	.02	8.5	0.0	7.2
36 - 42	C_{Ca}	2.6	.01	.01	1.0	5.5	8.0
STOCKTON LOAMY SAND, WELL-DRAINED ASSOCIATE							
0 - 3	A	13.8	2.81	.23	12.2	0.0	7.0
3 - 9	AB	6.1	.77	.07	11.0	0.0	6.9
9 - 18	C_1	3.9	.30	.03	10.0	0.0	6.9
18 - 30	C_1	3.6	.15	.02	7.5	0.0	6.9
30 - 42	C_2	4.2	.13	.03	4.3	0.0	6.8
42 - 54	C_2	3.8	.12	.01	12.0		
STOCKTON FINE SANDY LOAM, WELL-DRAINED ASSOCIATE							
0 - 9	A	24.6	4.83	.37	13.1	0.0	6.7
9 - 16	AB	12.8	1.80	.16	11.3	0.0	6.7
16 - 29	B	10.6	.74	.06	12.3	0.0	6.7
29 - 44	C_{Ca}	5.6	.27	.03	9.0	4.8	7.7
44 - 54	C	4.4	.14	.01	14.0	4.7	7.7
ALMASIPPI FINE SAND, IMPERFECTLY DRAINED ASSOCIATE							
0 - $2\frac{1}{2}$	A_{11}	45.7	13.58	.96	14.1	0.0	6.9
$2\frac{1}{2}$ - 11	A_{12}	8.3	1.35	.10	13.5	0.0	7.1
11 - 22	B	5.0	.34	.03	11.3	0.0	7.2
22 - 30	BC	4.6	.23	.01	23.0	0.0	7.4
30 - 36	C_{Ca}	6.2	.24	.02	12.0	4.6	8.3
36 - 42	C_{Ca}	4.6	.16	.01	16.0	4.2	8.0
42 - 48	C	3.2	.14	.01	14.0	2.6	7.8
FIRDALE LOAMY VERY FINE SAND, WELL-DRAINED ASSOCIATE							
0 - 2	O	31.0	6.74	.46	14.7	0.0	6.6
2 - 4	A_1	13.1	1.88	.13	14.5	0.0	6.6
4 - 16	A_2	10.8	.77	.06	12.8	0.0	6.2
16 - 21	B_1	16.2	.45	.04	11.3	0.0	6.3
21 - 26	B_2	16.2	.30	.04	7.5	0.0	6.5
26 - 35	B_3	12.0	.24	.04	6.0	0.0	7.0
35 - 40	C_{Ca}	11.5	.22	.03	7.3	5.3	7.8
40 - 48	C_{Ca}	8.7	.15	.02	7.5	5.8	7.7
48 - 54	C	8.5	.09	.01	9.0	4.1	7.8

TABLE 14

Analyses of Representative Soil Profiles—(Continued)

Depth	Horizon Designation	Moisture Equivalent	Organic Carbon	Nitrogen	C/N Ratio	Percent CO_3	Reaction (pH)
FIRDALE LOAM, WELL-DRAINED ASSOCIATE							
0 - 3	O	55.8	14.27	.89	16.3	0.0	6.6
3 - 8	A_{1+2}	20.4	2.53	.20	12.7	0.0	6.6
8 - 12	A_3	20.2	.68	.06	11.3	0.0	6.7
12 - 21	B_1	23.4	.36	.05	7.2	0.0	6.5
21 - 23	B_2	25.1	.45	.05	9.0	0.0	6.6
23 - 30	C_{Ca}	23.8	.41	.04	10.3	12.2	7.9
30 - 36	C_{Ca}	22.8	.27	.04	6.8	10.0	7.9
36 - 42	C	21.7	.21	.02	10.5	8.9	7.7
42 - 48	C	21.4	.20	.04	5.0	8.5	7.8
CARROLL SILTY CLAY LOAM, WELL-DRAINED ASSOCIATE							
0 - 2	A_{11}	36.6	5.65	.51	11.1	0.2	6.7
2 - 12	A_{12}	38.5	5.57	.50	11.1	0.2	6.9
12 - 18	B	31.6	2.11	.20	10.6	0.2	7.1
18 - 26	C_{Ca}	32.8	.61	.09	6.8	19.3	8.0
26 - 35	C	30.7	.41	.05	8.2	14.7	7.9
35 - 40	C	31.3	.09	.05	1.8	12.1	7.8
HOLLAND CLAY LOAM, WELL-DRAINED ASSOCIATE							
0 - 9	A	34.5	6.31	.52	12.1	0.4	7.1
9 - 18	AB	29.1	2.88	.27	10.7	0.1	7.1
18 - 27	B	25.2	1.04	.10	10.4	2.1	7.6
27 - 36	C_{Ca}	29.6	.65	.10	6.5	14.1	7.9
36 - 42	C	31.0	.32	.06	5.3	14.5	7.8
42 - 48	C	31.5	.35	.04	8.8	13.7	7.8
WELLWOOD CLAY LOAM, WELL-DRAINED ASSOCIATE							
0 - 2½	A_{11}	34.9	7.20	.55	13.1	0.0	6.6
2½ - 7½	A_{12}	34.4	5.62	.46	12.2	0.0	6.4
7½ - 15	AB	24.6	2.43	.20	12.2	0.0	6.1
15 - 30	B	22.5	.72	.07	10.3	0.0	6.2
30 - 46	C_{Ca}	12.8	.35	.03	11.7	6.1	7.6
46+	D	7.8	0.7	.01	7.0	5.3	7.5
LAKELAND CLAY LOAM, IMPERFECTLY DRAINED ASSOCIATE							
0 - 4½	A	40.9	9.78	.88	11.1	9.5	7.6
4½ - 8	AC	28.8	3.16	.30	10.5	6.4	7.8
8 13	C_{Ca}	28.8	1.30	.12	10.8	29.2	8.0
13 - 23	C	24.1	.28	.04	7.0	24.8	7.9
23 - 32	C	27.5	.29	.03	9.7	22.9	7.9
32 - 42	C	21.0	.15	.01	15.0	25.7	7.9

TABLE 14

Analyses of Representative Soil Profiles—(Continued)

Depth	Horizon Designation	Moisture Equivalent	Organic Carbon	Nitrogen	C/N Ratio	Percent CO_3	Reaction (pH)
PORTAGE SILTY CLAY LOAM, MODERATELY WELL DRAINED ASSOCIATE							
0 - 3	A_{11}	34.1	6.01	.51	11.8	0.4	7.5
3 - 9	A_{12}	33.0	5.45	.47	11.6	0.6	7.6
9 - 17	B	29.0	4.11	.37	11.1	1.6	7.7
17 - 25	C_{Ca}	26.9	1.63	.16	10.2	9.7	8.1
25 - 32	C	15.4	.40	.04	10.0	9.9	8.2
32 - 40	C	13.9	.27	.03	9.0	9.2	8.2
40 - 48	C_g	20.5	.30	.03	10.0	10.6	8.0
OAKVILLE SILTY CLAY, IMPERFECTLY DRAINED ASSOCIATE							
0 - 3	A	40.2	5.35	.48	11.1	0.1	7.3
3 - 9	—	38.6	4.72	.39	12.1	0.2	7.6
9 - 13	AC	32.2	1.41	.15	9.6	1.0	7.9
13 - 18	—	29.0	.52	.09	5.8	2.7	7.9
18 - 24	C	27.7	.54	.07	7.7	3.9	7.8
24 - 30	C_g	33.8	.50	.07	7.1	3.6	8.2
30 - 36	—	35.2	.37	.05	7.4	3.9	8.3
36 - 44	—	40.0	.38	.06	6.3	4.1	8.4
BURNSIDE SILTY CLAY, IMPERFECTLY DRAINED ASSOCIATE							
0 - 2½	A_{11}	34.2	6.86	.57	12.0	0.4	7.1
2½ - 9	A_{12}	37.2	3.97	.40	9.9	0.3	7.2
9 - 15	B	32.6	1.40	.46	3.0	2.8	7.5
15 - 22	C_{Ca}	29.5	.71	.08	8.9	16.1	8.0
22 - 30	C	26.5	.27	.04	6.8	14.6	8.0
30 - 42	C	30.2	.05	.04	1.3	12.4	8.0
RATHWELL HEAVY CLAY LOAM, MODERATELY WELL DRAINED ASSOCIATE							
0 - 2	O	42.5	8.45	.60	14.1	0.0	7.2
2 - 6	A	36.9	5.90	.45	13.1	0.0	6.8
6 - 16	B_1	29.8	2.21	.20	11.1	0.0	6.6
16 - 23	B_2	33.1	.83	.11	7.5	0.0	6.8
23 - 30	C_{Ca}	30.4	.47	.06	7.8	16.2	7.7
30 - 36	C	30.8	.28	.05	5.6	12.9	7.8
36 - 42	C_g	32.0	.29	.05	5.8	10.7	7.8
42 - 48	C_g	33.3	.28	.05	5.6	9.5	7.6
HARDING CLAY, IMPERFECTLY DRAINED ASSOCIATE (Solonetzic)							
0 - 3	O	42.9	4.77	.49	9.7	0.4	7.3
3 - 6	A_{11}	42.4	4.82	.49	9.8	0.2	7.2
6 - 9	A_{12}	37.1	1.66	.26	6.4	1.7	7.3
9 - 15	B	35.1	.78	.13	6.0	2.5	7.5
15 - 21	C_1	33.5	.24	.11	2.2	4.2	7.5
21 - 27	C_1	35.4	.15	.10	1.5	5.0	7.5
27 - 33	C_1	35.8	....	.09	....	5.2	7.6
33 - 42	C_2	35.3	....	.05	....	6.0	7.6

TABLE 14

Analyses of Representative Soil Profiles—(Continued)

Depth	Horizon Designation	Moisture Equivalent	Organic Carbon	Nitrogen	C/N Ratio	Percent CO_3	Reaction (pH)
RED RIVER CLAY, IMPERFECTLY DRAINED ASSOCIATE (Solonetzic)							
0 - 2½	A	62.1	13.13	1.10	11.9	0.3	6.6
2½ - 9	B_2	43.5	1.39	.23	6.0	0.5	7.0
9 - 18	B_3	34.2	.28	.08	3.5	8.2	7.4
18 - 29	C_{Ca}	31.8	.00	.08	....	9.5	7.3
29 - 42	C	33.4	.08	.07	1.1	7.1	7.3
NEWDALE CLAY LOAM, WELL DRAINED ASSOCIATE							
0 - 3	A_{11}	39.0	8.90	.73	12.2	0.4	7.1
3 - 9	A_{12}	27.7	4.01	.34	11.8	0.2	7.1
9 - 12	AB	25.8	1.25	.14	8.9	3.0	7.5
12 - 15	B	23.4	.82	.11	7.5	12.1	7.6
15 - 18	BC	23.2	.69	.08	8.6	13.2	7.6
18 - 24	C_{Ca}	25.8	.67	.07	9.6	15.5	7.6
24 - 30	C	25.7	.56	.04	14.0	15.1	7.7
30 - 36	C	24.7	.55	.04	13.8	14.2	7.8
BERESFORD CLAY LOAM, WELL DRAINED ASSOCIATE							
0 - 2	A_{11}	45.8	9.79	.72	13.6	0.0	6.4
2 - 6	A_{12}	33.4	5.20	.47	11.1	0.0	6.5
6 - 10	AB	28.2	2.78	.24	11.6	0.0	6.6
10 - 14	B	24.6	1.02	.17	6.0	0.2	6.8
14 - 20	BD	20.5	.82	.12	6.8	7.9	7.4
20 - 28	D_{Ca}	24.1	.38	.05	7.6	19.4	8.0
28 - 36	D_{Ca}	21.6	.16	.01	16.0	20.9	7.9
36 - 42	D	22.6	.24	.03	8.0	18.8	7.9

TABLE 15

Mechanical Analysis of Representative Surface Soil Samples From the Carberry Map Area

Samples	Dominant Soil Type	Condition	SAND					Silt .05 to .002 mm.	Clay Less than .002 mm.
			Fine Gravel 2.0 to 1.0 mm.	Coarse Sand 1.0 to 0.5 mm.	Medium Sand 0.5 to .25 mm.	Fine Sand .25 to .1 mm.	Very Fine Sand .1 to .05 mm.		
3	Stockton fine sandy loams	Virgin	.14	1.96	17.84	28.06	20.80	19.25	11.95
10	Stockton fine sandy loams	Cult.	.14	1.03	9.47	36.21	23.81	16.84	12.50
2	Stockton loamy sands	Virgin	.00	.52	8.35	61.71	15.33	5.58	8.51
2	Carroll silty clay loams	Virgin	.01	.30	1.75	5.64	14.45	54.87	22.98
4	Carroll clay loams	Cult.	.00	.20	1.47	9.80	18.00	44.24	26.29
2	Newdale clay loams	Cult.	1.17	2.89	5.95	17.42	12.60	35.00	24.97
2	Almasippi loamy sands	Virgin	.16	.23	1.47	41.76	30.19	13.52	12.67
14	Almasippi loamy sands	Cult.	.04	.88	4.82	48.18	28.03	9.68	8.37
6	Almasippi sands	Virgin	.00	.07	1.48	63.86	19.62	8.51	6.46
6	Almasippi sands	Cult.	.05	1.97	18.57	53.28	13.69	5.89	6.55
1	Burnside heavy clay loams	Cult.	.27	1.17	4.11	7.31	8.39	44.69	34.06
3	Portage silty clay loams	Cult.	.00	.19	2.71	9.47	12.27	49.86	25.50
2	Portage silty clays	Cult.	.00	.04	.57	5.05	6.59	54.79	32.96
6	Firdale very fine sandy loam	Cult.	.00	.02	.75	22.99	36.70	25.91	13.63
3	Firdale clay loams	Cult.	.00	.08	.35	13.56	26.27	35.37	24.37
2	Rathwell heavy clay loams	Cult.	.00	.26	.84	11.03	11.92	42.54	33.41
2	Holland loams	Virgin	.00	.00	.09	10.34	28.35	41.77	19.45
5	Wellwood clay loams	Cult.	.04	.27	4.23	17.99	18.85	37.40	21.22
3	Oakville silty clays	Cult.	.06	.11	1.44	3.29	3.07	50.12	41.91
4	Oakville heavy clay loams	Virgin	.00	.29	1.27	9.85	9.85	46.94	31.80
2	Gladstone silt loams	Cult.	.00	.02	.10	5.37	19.35	58.12	17.04
4	Riverdale silty clay loams	Cult.	.00	.00	.33	1.15	3.72	66.80	28.00
2	Beresford silty clay loams	Virgin	1.03	1.97	3.15	5.10	8.93	54.86	24.96
1	Lakeland clay loams	Virgin	.80	.77	2.10	12.14	16.96	41.63	25.60
1	Westbourne clay	Virgin	1.74	1.57	1.88	3.69	4.24	37.40	49.48
1	Red River clay	Cult.	.00	.26	2.59	2.36	1.14	40.41	53.24
2	Isafold clay loams	Virgin	3.43	4.75	8.78	10.84	4.08	34.97	33.15
4	Marringhurst sandy loams	Virgin	7.53	20.41	25.19	14.99	4.16	17.87	9.85

TABLE 16

Moisture-Retention Capacity and Indications of Fertility Shown by Surface Soil Samples From the Carberry Map Area

Soils Mapped As Association	Condition: Virgin—V Cultivated—C	No. of Samples	Moisture Equivalent	INDICATIONS OF FERTILITY				
				No. of Samples	Percent Total Nitrogen	Available Phosphate	Available Potash	Reaction
Stockton fine sandy loam	V	28	19.4	6	.25	L-M	MH	6.8
Stockton fine sandy loam	C	22	15.4	6	.18	L-M	M	7.0
Stockton loamy sand	V	9	10.0	4	.20	L-M	M	6.8
Stockton loamy sand	C	6	7.8	4	.20	L-M	M	6.8
Firdale clay loam	V	8	24.0	4	.24	M-L	MH	7.1
Firdale clay loam	C	5	22.5	4	.14	M-L	MH	7.2
Firdale loam	V	15	22.4	5	.32	M	MH	7.1
Firdale loam	C	15	20.0	5	.16	L-M	M	7.4
Miniota association	V	14	11.9	5	.14	L	L-M	6.9
Miniota association	C	3	8.6	2	.21	L	M	6.5
Marringhurst association	V	11	23.8	6	.28	L	L-M	6.8
Marringhurst association	C	..	....	.	...	....	....	...
Almasippi sand	V	15	9.9	5	.09	L-M	L-M	7.0
Almasippi sand	C	18	9.8	5	.16	M-L	M-L	7.5
Almasippi loamy sand	V	25	19.0	7	.26	M-L	L-M	7.6
Almasippi loamy sand	C	37	15.5	9	.25	L-M	L-M	7.7
Portage association	V	12	34.1	6	.54	L-M	H	7.2
Portage association	C	16	31.1	5	.41	L	H	7.3
Oakville association	V	5	35.3	4	.25	L-M	H	6.8
Oakville association	C	10	35.0	7	.28	L	H	7.1
Gladstone association	V	10	31.3	4	.45	M-L	MH	8.1
Gladstone association	C	12	28.2	4	.44	M-L	M	8.0
Wellwood association	V	13	28.2	5	.42	L-M	MH	6.9
Wellwood association	C	18	27.2	5	.34	L-M	M	6.9
Carroll association	V	6	29.0	1	.55	L	M	7.4
Carroll association	C	1	25.9	1	.31	VL	H	7.5
Harding association	V	2	38.5	.	...	....	....	...
Harding association	C	2	35.6	.	...	....	....	...
Burnside association	V	7	33.8	4	.47	L	H	7.3
Burnside association	C	6	32.3	4	.32	L	MH	7.2
Holland association	V	3	27.3	3	.36	L	MH	7.3
Holland association	C	1	23.7	1	.28	L	M	7.4
Newdale association	V	6	32.9	4	.52	L-M	H	7.4
Newdale association	C	6	30.6	4	.37	L	H	7.6
Westbourne association	V	5	42.4	4	.50	L-M	H	7.8
Westbourne association	C	1	41.5	1	.42	L-M	VH	7.7
Rathwell association	V	.	....	.	...	....	....	...
Rathwell association	C	4	28.5	4	.29	L	M	7.3
Beresford association	V	3	32.9	2	.41	L	MH	7.1
Beresford association	C	.	....	.	...	....	....	...
Red River association	V	2	42.5	2	.56	L	VH	7.4
Red River association	C	3	42.6	2	.42	L	H	7.4
Riverdale association	V	4	37.3	4	.32	L-M	H	7.6
Riverdale association	C	3	34.3	3	.26	L	H	7.7
Isafold association	V	4	42.5	3	.66	L	MH	7.8
Isafold association	C	.	....	.	...	....	....	...
Lakeland association	V	2	40.6	2	.61	L	H	7.8
Lakeland association	C	1	32.7	1	.48	L	MH	7.8

	Phosphate (p.p.m.)	Potash (p.p.m.)
Extra high (EH)	.....	250+
Very high (VH)	100+	200–250
High (H)	50–100	150–200
Medium high (MH)	25–50	100–150
Medium (M)	12–25	75–100
Low (L)	5–12	0–75
Very low (VL)	0–5	.....